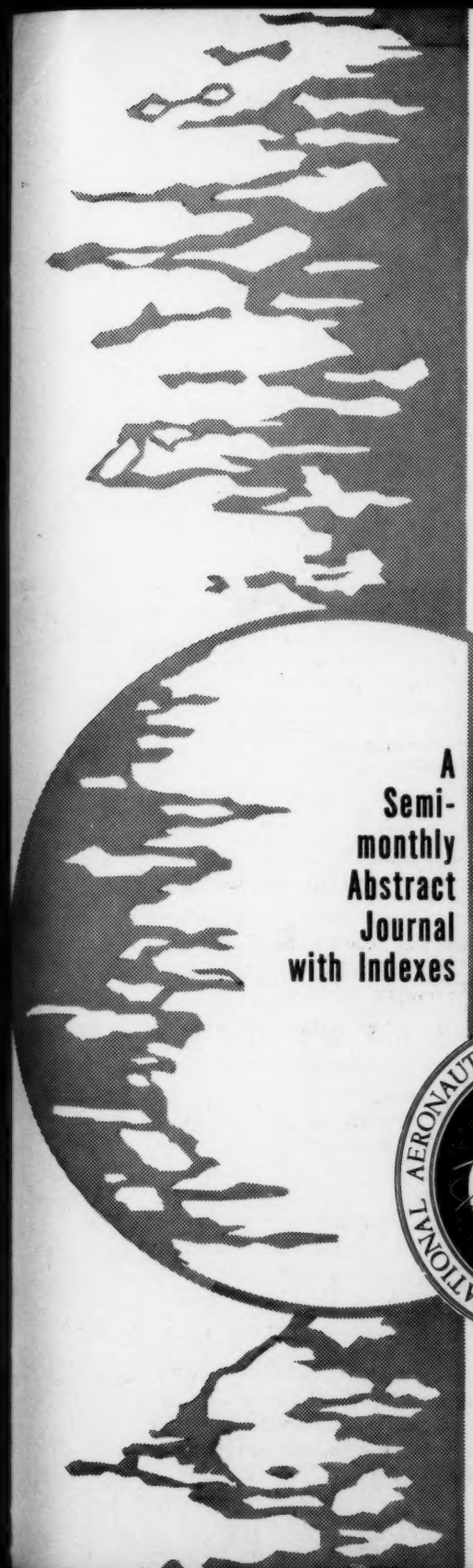

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VOLUME 1 NUMBER 9

# Scientific and Technical Aerospace Reports

*A Semimonthly Publication of the National Aeronautics and Space Administration*

**May 8, 1963**

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Includes: management; space law and legal matters; symposia or conferences of a broad or a general nature.

**N63-13811** American Institute for Research, Pittsburgh, Pa.
**SOME PROCEDURES IN DESIGN FOR MAINTAINABILITY [Final] Technical Documentary Report**
James W. Altman Wright-Patterson AFB, Ohio, Behavioral Sciences Lab., Feb. 1962 49 p 3 refs
(Contract AF 33(616)-6124)
(MRL-TDR-62-9)

Emphasis in this report is on suggested procedures for including maintenance design considerations in advanced-systems analysis and conceptual design. However, maintenance design procedures applicable to development, production, and operational phases are identified. The types of maintenance design requirements and specifications that should be prepared, the purposes they serve, useful content and organization, background sources, and priorities for different requirements are discussed. A systematic approach to the identification and analysis of required maintenance functions is described. Major steps in functions analysis are the identification of different maintenance areas; separate approaches to the identification of preventive, corrective, recycle, and direct support functions; collation, combination, and organization of maintenance functions; and tradeoff of functions between man and machine. Considerations in the preparation of maintenance concepts and development plans are identified. The place of specific development procedures for the various maintenance supports in total maintenance design is identified. Some of the general considerations in evaluation and test of maintenance design are discussed. Author

**N63-13931** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
**JPL BIBLIOGRAPHY NO. 39-4, PRERELEASE NO. 1, JULY 1 THROUGH JULY 31, 1962**
Aug. 8, 1962 24 p 21 refs
(NASA Contract NAS7-100)
(JPL-Bibl-39-4(1)) OTS: $2.60 ph, $0.92 mf

**N63-13997** National Research Council of Canada, Ottawa
**QUARTERLY BULLETIN OF THE DIVISION OF MECHANICAL ENGINEERING AND THE NATIONAL AERONAUTICAL ESTABLISHMENT, 1 OCTOBER TO 31 DECEMBER 1962**
[1962] 124 p
(DNE/NAE-1962 (4))
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1. CENTRIFUGAL COMPRESSORS H. S. Fowler and C. K. Rush (Div. of Mechanical Engineering) p 35-54 (See N63-13998 09-17)

**N63-14104** Mitsubishi Electric Mfg. Co., Ltd. Research Lab., Amagasaki (Japan)
**MITSUBISHI DENKI LABORATORY REPORT, VOLUME 4, NUMBER 1**
Jan. 1963 146 p 40 refs
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8. THE INFRARED ABSORPTION SPECTRA OF METHYLISOCYANATOSILANES H. Manami and S. Nishizaki p 139-142 7 refs (See N63-14112 09-07)

**N63-14113** Advisory Group for Aeronautical Research and Development, Paris (France)
**MANUAL ON AEROELASTICITY. PART V. FACTUAL INFORMATION ON FLUTTER CHARACTERISTICS**
W. P. Jones (Natl. Phys. Lab., Gt. Brit.), ed. [1961] 304 p 234 refs
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**N63-14226** Congress. House. Committee on Science and Astronautics

**QUALIFICATIONS FOR ASTRONAUTS Hearings before the Special Subcommittee on the Selection of Astronauts of the Committee on Science and Astronautics, U.S. House of Representatives, July 17-18, 1962**

Washington, GPO, 1962 86 p

(87th Cong. 2nd Sess. Committee Print No. 9)

These hearings include the statements of Jane B. Hart, Jerrie Cobb, and Jacqueline Cochran on behalf of women astronauts. Then, the statement of George M. Low on the present NASA qualifications for astronauts is given. R.C.M.

# 02 AERODYNAMICS OF BODIES, COMBINATIONS, AND INTERNAL FLOW

Includes: aerodynamics of channels, cowls, ducts, ejectors, nozzles, etc.

*For related information see:* 03 Aerodynamics of Wings, Rotors and Control Surfaces; and 11 Fluid Mechanics.

**N63-13788** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

**LONGITUDINAL AERODYNAMIC CHARACTERISTICS AT MACH NUMBERS FROM 0.40 TO 1.10 OF A BLUNTED RIGHT-TRIANGULAR PYRAMIDAL LIFTING REENTRY CONFIGURATION EMPLOYING VARIABLE-SWEEP WING PANELS**

Bernard Spencer, Jr. Washington, NASA, Mar. 1963 70 p 10 refs

(NASA TN D-1518) OTS: $1.75

An investigation has been conducted in the Langley 7- by 10-foot transonic tunnel at Mach numbers from 0.40 to 1.10 on a right-triangular pyramidal-type reentry configuration employing variable wing sweep as a means of increasing lift and lift-drag ratio at subsonic speeds. Various means of longitudinal control were also tested in conjunction with the range of wing-panel sweep at a Mach number of 0.40. The results indicated that reducing the sweep of the wing panels from 80° to 0° at a Mach number of 0.40 increased the maximum lift-drag ratio of the basic configuration from 2.55 to 5.65 and increased the lift-curve slope from 0.0195 to 0.0565 with little or no change in the low-lift stability level for the configuration with all controls off. The configuration having 30° or 40° sweep provided the highest lift coefficient for the maximum angle-of-attack range of the investigation. Wing-panel leading-edge sweep angles below 30° indicated stalling and rapid losses in lift coefficient occurring at moderate angles-of-attack. Comparison of the longitudinal control characteristics of a high and low horizontal tail and a trailing-edge flap control indicated the highest values of control effectiveness for the high-positioned horizontal tail. Use of the trailing-edge flap control provided trim conditions throughout the angle-of-attack range. Author

**N63-13791** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

**EXPERIMENTAL INVESTIGATION OF THE DYNAMIC STABILITY OF A TOWED PARAWING GLIDER MODEL**

Robert E. Shanks Washington, NASA, Mar. 1963 15 p 2 refs

(NASA TN D-1614) OTS: $0.50

An investigation of the dynamic stability characteristics of a towed parawing glider has been made in the Langley full-scale tunnel by means of free-flight model tests. The model was tested in its basic configuration (wing, risers, and a steel weight representing a payload) and with various amounts of vertical side area added in the plane of symmetry beneath the wing. The investigation showed that the basic configuration had unsatisfactory tow characteristics because of a large, constant-amplitude lateral oscillation which seemed to consist of a large amount of sidewise motion in proportion to the roll and yaw. It was found that the addition of vertical side area could provide satisfactory tow characteristics if the area was properly located. It should be pointed out that in this investigation the model did not have a cargo package of any appreciable dimensions and, therefore, only the aerodynamics of the wing and vertical panels were involved. For other configurations a somewhat different arrangement of side area might be necessary to achieve satisfactory tow. Author

**N63-13802** Aeronautical Research Council (Gt. Brit.)

**ON THE DESIGN OF WING-BODY COMBINATIONS OF LOW ZERO-LIFT DRAG RISE AT TRANSONIC SPEEDS**

W. T. Lord London, HMSO, 1962 47 p 25 refs

(ARC-R&M-3279; previously issued as ARC-22503) Available from HMSO: 18s. 6d.

The paper concerns the transonic area rule, which states that the variation of zero-lift drag of an aircraft configuration at transonic speeds depends primarily on its axial distribution of cross-sectional area. The detailed discussion concerns a more restricted but more explicit result; namely, that the drag jump (the discontinuity in zero-lift wave drag predicted by linearized theory at sonic speed) of a smooth wing-body combination is given by a formula which involves only area distribution of the combination; this result is called the sonic area rule. The discussion does not consider in detail the relation of the sonic area rule to the entire problem of drag rise, but makes contributions to the use of the sonic area rule in the design of wing-body combinations of low drag rise. Results for several optimum area distributions for minimum drag jump are given, in a more compact and enlightening form than previously obtained. Some simple, yet fairly general, cases of the design of wing-body combinations of low drag jump are discussed, and a numerical example is given; the cases investigated illustrate some of the principal features of design for low transonic drag rise. Author

**N63-13832** Aerospace Corp. Aerodynamics and Propulsion Research Lab., El Segundo, Calif.

**OPTIMUM SHAPES WITH RESPECT TO THE SONIC BOOM PROBLEM**

Inge L. Ryhming [1962] 21 p 5 refs Presented at the Symp. on External Problems in Aerodynamics, Boeing Sci. Research Labs., Seattle, Dec. 3-4, 1962

In the far flow field of a supersonic projectile, the shock-wave strength of the bow shock depends to some extent on the shape of the projectile. The shape dependence can be expressed in terms of an integral (shape factor) over a certain function, which in turn is defined as an integral over another function related to the cross-section area variation of the projectile. The problem of finding projectiles that have a minimum value of the shape factor is reviewed as well as some basic concepts of the Whitham theory pertinent for the discussion of the formulation of the optimum problems. One conclusion from these investigations is that minimum boom and minimum drag require the same shape. The similar problem for wing-body configurations is also reviewed with emphasis on the physics of the problem. Author

**N63-13849** Aeronautical Research Council (Gt. Brit.)

**PRESSURE MEASUREMENTS ON A CONE-CYLINDER-FLARE CONFIGURATION AT SMALL INCIDENCES FOR $M_\infty = 6.8$**

J. G. Woodley London, HMSO, 1963 15 p 5 refs

(ARC-CP-632; previously issued as RAE-TN-AERO-2739, ARC-23047) Available from HMSO: 2s. 6d.

Pressure measurements were made on a slender cone-cylinder-flare configuration, slightly blunted at the nose, for 0, 3 and 6 degrees incidence at a free-stream Mach number of 6.8. It was found that the surface pressures obtained on the cone agreed with extrapolations to $M\infty = 6.8$ of theoretical values given in M.I.T. tables (Kopal) for yawed cones, and that impact theory gave a good indication of the pressure level to be expected on all parts of the body where surface incidence was sufficiently large to merit its use. The semiangles of the conical and flared parts of the model were both 7½ degrees, and along each generator of the body, the pressure level on the flare rose in all cases to approximately that developed upstream on the cone surface. No evidence of a marked over-expansion to pressures below the free-stream value was noticed at the junction between cone and cylinder. Author

**N63-13850** Aeronautical Research Council (Gt. Brit.)

**THEORETICAL COMPARISON OF THE FLOW OVER A FLAT DELTA WING AND A RECTANGULAR PYRAMID**

E. Eminton London, HMSO, 1963 22 p 6 refs

(ARC-CP-637; previously issued as RAE-TN-AERO-2793, ARC-23600) Available from HMSO: 3s. 6d.

Slender-body theory is used to compare the flow over the bottom surface of a flat delta wing at incidence and the delta-like surfaces of a pyramid of rectangular section, interest being focused on the center line and on the flow attachment lines where they exist. Pyramids are found which reproduce closely the flow in the neighborhood of the delta center line. Other pyramids are found which have the position of the attachment lines as a delta wing, the approximation to the flow being good when the attachment lines are near the center line but deteriorating as they move outboard. Author

**N63-13860** National Advisory Committee for Aeronautics. Langley Aeronautical Laboratory, Langley Field, Va.

**THE ORIGIN AND DISTRIBUTION OF SUPERSONIC STORE INTERFERENCE FROM MEASUREMENT OF INDIVIDUAL FORCES ON SEVERAL WING-FUSELAGE-STORE CONFIGURATIONS. I.—SWEPT-WING HEAVY-BOMBER CONFIGURATION WITH LARGE STORE (NACELLE). LIFT AND DRAG; MACH NUMBER, 1.61**

Norman F. Smith and Harry W. Carlson Washington, NACA, Mar. 11, 1955 151 p 9 refs

(NACA RM L55A13a) OTS: $11.50 ph, $4.73 mf (Declassified)

A supersonic wind-tunnel investigation of the origin and distribution of store interference has been performed in the Langley 4- by 4-foot supersonic pressure tunnel at M = 1.6 in which separate forces on a store, a fuselage, a swept wing, and a swept-wing-fuselage combination were measured. The store was separately sting-mounted on its own six-component internal balance and was traversed through a wide systematic range of spanwise, chordwise, and vertical positions. The configuration investigated simulated a heavy bomber-type airplane with a large store which also represented a nacelle having frontal area equivalent to a twin-engine nacelle. Large changes in store and wing-fuselage drag may occur with small changes in store position—either spanwise, chordwise, or vertically. The interference drag of the store in the presence of the wing or fuselage is explained in a qualitative (and to some extent quantitative) way from consideration of the pressure field of the wing or fuselage and the resultant buoyant forces on the store. The store interference drag measured in the presence of the wing-fuselage combination compares favorably with the sum of the store interference drags measured in the presence of fuselage alone and in the presence of the wing alone. The interference drags of the wing and fuselage arising from the flow field of the store are similarly explained from considerations of the position of the wing and fuselage in the pressure field of the store. The fact that, in most store positions investigated, the simple buoyancy considerations were useful indicates that reflected disturbances and the possible presence of local choking between components did not materially contribute to the interference. Store positions for which high drag is encountered by the store are the same positions, in general, for which high drag is also encountered by the wing-fuselage combination. The same is true, in general, for store positions for low drag. No consistent correlation was obtained between the drags of the complete configuration and a visual inspection of the area diagrams for these configurations determined according to the supersonic area-rule concept. Author

**N63-13861** National Advisory Committee for Aeronautics. Lewis Flight Propulsion Lab., Cleveland, Ohio

**PERFORMANCE AT MACH NUMBERS 3.07, 1.89, AND 0 OF INLETS DESIGNED FOR INLET-ENGINE MATCHING UP TO MACH 3**

L. W. Gertsma and M. A. Beheim Washington, NACA, May 20, 1958 51 p 1 ref

(NACA RM E58B13) OTS: $5.60 ph, $1.73 mf (Declassified)

The performance of a two-dimensional external-compression inlet designed for various methods of inlet-engine matching up to Mach 3 was investigated at Mach 1.89 and Mach 0. Angle-of-attack data at Mach 3.07 were also obtained. Supersonic spillage, caused by rotating the ramp as a unit, gave higher critical pressure recoveries and smaller distortions than any other matching method investigated for the two-shock and, at the lower mass flows, for the isentropic inlets. The throat bypass had the best performance of the bypasses with both ramps, and especially with isentropic ramp at mass-flow ratios near 80 percent. All configurations were stable over a range of mass flow of 10 percent or better at zero angle-of-attack. When the top bypass was used as an auxiliary inlet at Mach 0 with the flow divider rotated into the free-stream, pressure recovery increased and distortion decreased. With the flow divider out and only the top door open, the increase in recovery was not as large and distortion was increased. Author

**N63-13862** National Advisory Committee for Aeronautics. Langley Aeronautical Lab., Langley Field, Va.

**SUMMARY OF SUBSONIC-DIFFUSER DATA**

John R. Henry, Charles C. Wood, and Stafford W. Wilbur Washington, NACA, Oct. 12, 1956 131 p 47 refs

(NACA RM L56F05) OTS: $10.50 ph, $4.13 mf (Declassified)

The subsonic-diffuser data available in the literature are reviewed, reduced to certain appropriate performance coefficients, and presented as functions of the significant geometric and flow variables. The presentation is divided into the following parts: performance at low speeds (inlet Mach numbers of approximately 0.20), the effects of increasing the inlet speed up to choking Mach numbers, illustrations of the effectiveness of boundary-layer controls, and illustrations of the effects of distorted inlet velocity distributions as obtained at subsonic speeds with spoilers upstream from the inlet and as obtained from compression shocks in supersonic inlets. An analysis based on typical supersonic-inlet data indicates total-pressure losses chargeable to shock-boundary-layer interaction, and original data on a 5° converging-diverging conical diffuser illustrates these effects on the flow development throughout the diffuser. Author

**N63-13865** National Advisory Committee for Aeronautics. Lewis Flight Propulsion Lab., Cleveland, Ohio

**PERFORMANCE OF ISENTROPIC NOSE INLETS AT MACH NUMBER OF 5.6**

Harry Bernstein and Rudolph C. Haefeli Washington, NACA, May 6, 1954 40 p 13 refs

(NACA RM E54B24) OTS: $3.60 ph, $1.40 mf (Declassified)

Performance of inlet configurations with a forebody designed for isentropic external compression was investigated at a nominal Mach number of 5.6 and a Reynolds number based on maximum model diameter of $1.48 \times 10^6$. At zero angle-of-attack, all the

configurations yielded larger total-pressure recoveries than had previously been obtained with a single-conical-shock inlet. In addition, the internal thrust coefficients were larger for some of the isentropic inlets than for the conical inlet. Performance comparable with that at zero angle-of-attack was obtained at a 3° angle-of-attack. For a configuration having an internal passage with a constant-area section of 2.72 hydraulic diameters, stability was achieved to mass-flow ratios as low as 0.62. With the same configuration, stability was maintained to mass-flow ratios as low as 0.11 by bleeding air through orifices in the forebody near the inlet entrance. Author

**N63-13868** National Advisory Committee for Aeronautics. Langley Aeronautical Lab., Langley Field, Va.

**THE ORIGIN AND DISTRIBUTION OF SUPERSONIC STORE INTERFERENCE FROM MEASUREMENT OF INDIVIDUAL FORCES ON SEVERAL WING-FUSELAGE-STORE CONFIGURATIONS. II—SWEPT-WING HEAVY-BOMBER CONFIGURATION WITH LARGE STORE (NACELLE). LATERAL FORCES AND PITCHING MOMENTS; MACH NUMBER, 1.61**

Norman F. Smith and Harry W. Carlson Washington, NACA, July 6, 1955 146 p 4 refs

(NACA RM L55E26a) OTS: $11.00 ph, $4.85 mf (Declassified)

A supersonic wind-tunnel investigation of the origin and distribution of store interference has been performed in the Langley 4- by 4-foot supersonic pressure tunnel at a Mach number of 1.6. Separate forces on a store, a fuselage, a swept wing, and a swept-wing—fuselage combination were measured. The store was separately sting-mounted on its own six-component internal balance and was traversed through a wide systematic range of spanwise, chordwise, and vertical positions. The configuration investigated simulated a heavy bomber airplane with a large store, or nacelle, having frontal area equivalent to a twin-engine nacelle. Large changes in store and wing-fuselage forces and moments may occur with small spanwise or chordwise changes in store position. The effects of vertical position of the store are relatively small. The increases which occur with configuration angle-of-attack are somewhat larger for store side force than for store lift. Store side force is probably the important load from the standpoint of store-support design. The measured store moments are large at zero angle-of-attack, but do not display the large increases with angle-of-attack which were measured for the other store forces. The wing is shown to be the predominant factor in the production of all interference forces and moments on the store. The effect of the fuselage is very small in the case of store lift and pitching moment, but it is of significant magnitude in the case of store side force and yawing. Author

**N63-13869** National Advisory Committee for Aeronautics. Langley Aeronautical Lab., Langley Field, Va.

**THE ORIGIN AND DISTRIBUTION OF SUPERSONIC STORE INTERFERENCE FROM MEASUREMENT OF INDIVIDUAL FORCES ON SEVERAL WING-FUSELAGE-STORE CONFIGURATIONS. VI—SWEPT-WING HEAVY-BOMBER CONFIGURATION WITH STORES OF DIFFERENT SIZES AND SHAPES**

Norman F. Smith Washington, NACA, Mar. 8, 1956 88 p 4 refs

(NACA RM L55L08) OTS: $8.10 ph, $2.84 mf (Declassified)

A supersonic wind-tunnel investigation of the origin and distribution of store interference has been performed in the Langley 4- by 4-foot supersonic pressure tunnel at a Mach number of 1.61, in which separate forces on a store, a fuselage, a swept wing, and a swept-wing—fuselage combination were measured. This report presents data on a configuration which simulated a heavy-bomber airplane with stores of several shapes and sizes. Author

**N63-13870** National Advisory Committee for Aeronautics. Langley Aeronautical Lab., Langley Field, Va.

**THE ORIGIN AND DISTRIBUTION OF SUPERSONIC STORE INTERFERENCE FROM MEASUREMENT OF INDIVIDUAL FORCES ON SEVERAL WING-FUSELAGE-STORE CONFIGURATIONS. V—SWEPT-WING HEAVY-BOMBER CONFIGURATION WITH LARGE STORE (NACELLE). MACH NUMBER 2.01**

Harry W. Carlson and Douglas J. Geiger Washington, NACA, Feb. 13, 1956 122 p 3 refs

(NACA RM L55K15) OTS: $10.10 ph, $3.86 mf (Declassified)

A supersonic wind-tunnel investigation of store interference has been performed in the Langley 4- by 4-foot supersonic pressure tunnel at a Mach number of 2.01 in which separate forces on a store and a swept-wing-fuselage combination were measured. The store was separately sting-mounted on its own six-component internal balance and was traversed through a wide systematic range of spanwise, chordwise, and vertical positions. This report presents data on a configuration which simulated a heavy-bomber airplane with a large external store. The interference effects measured for the heavy-bomber configuration at a Mach number of 2.01 were similar in character and magnitude to those reported previously at a Mach number of 1.61. In general, the maximum interference force coefficients at the higher Mach number are slightly less and the curves are displaced in the direction of the Mach line shift. Linearized-theory calculations of the effect of the wing-fuselage flow field on store drag have been made. Author

**N63-13871** National Advisory Committee for Aeronautics. Langley Aeronautical Lab., Langley Field, Va.

**THE ORIGIN AND DISTRIBUTION OF SUPERSONIC STORE INTERFERENCE FROM MEASUREMENT OF INDIVIDUAL FORCES ON SEVERAL WING-FUSELAGE-STORE CONFIGURATIONS. IV.—DELTA-WING HEAVY-BOMBER CONFIGURATION WITH LARGE STORE; MACH NUMBER, 1.61**

Odell A. Morris Washington, NACA, Dec. 15, 1955 128 p 6 refs

(NACA RM L55127a) OTS: $10.10 ph, $4.04 mf (Declassified)

A supersonic wind-tunnel investigation of the origin and distribution of store interference has been performed in the Langley 4- by 4-foot supersonic pressure tunnel at a Mach number of 1.6 in which separate forces on a store and on a 60° delta-wing—fuselage combination were measured. The store was separately mounted on its own five-component internal balance and was traversed through a wide range of spanwise, chordwise, and vertical positions. The configuration presented in this report simulates a heavy-bomber delta-wing airplane, and has a large external symmetrical store that represents a nacelle having a frontal area equivalent to a twin-engine nacelle. The results indicated that the interference effects measured for the 60° delta-wing—fuselage combination were similar in character and magnitude to those previously reported for a 45° swept-wing—fuselage combination tested in the presence of the same store. However, the variation of the interference values of lift and drag with store chordwise position produced on the store by the 60° delta-wing—fuselage combination was somewhat smaller than the variation shown for the 45° swept-wing—fuselage combination. Also, the interference drag on the store, produced by the presence of the wing and the fuselage, is explained in a qualitative way by using the "buoyancy" method which considers the pressure field of the wing and fuselage and the resultant buoyant forces on the store. Author

**N63-13872** National Advisory Committee for Aeronautics. Lewis Flight Propulsion Lab., Cleveland, Ohio

**PERFORMANCE OF AN INLET HAVING A VARIABLE-ANGLE TWO-DIMENSIONAL COMPRESSION SURFACE AND A FIXED-GEOMETRY SUBSONIC DIFFUSER FOR APPLICATION TO REDUCED ENGINE ROTATIVE SPEEDS: MACH NUMBERS 0.66, 1.5, 1.7, AND 2.0**

John L. Allen Washington, NACA, Jan. 30, 1958 32 p 7 refs

(NACA RM E57J02) OTS: $3.60 ph, $1.16 mf (Declassified)

The performance of a two-dimensional side inlet embodying a technique of varying compression-surface angle while retaining a fixed-geometry diffuser was determined at Mach numbers of 0.66, 1.5, 1.7, and 2.0 at zero angle of attack. A 12° compression ramp was faired into the diffuser contour in the conventional manner. However, for larger ramp angles only the ramp forward of the throat-bleed slot rotated (leading-edge pivot) and the diffuser contour aft

of the slot region remained fixed. The higher ramp angles resulted in step increases in diffuser area in the throat-slot region that were 1.24 and 1.73 times the throat areas for the 17° and 22° ramp angles, respectively. The mass flow captured by the inlet was decreased sufficiently by shock spillage due to increasing ramp angle to satisfy turbojet engine windmilling airflow requirements with total-pressure flow distortions at the diffuser exit less than those for design ramp angle and maximum engine airflow. Severe ramp boundary-layer separation occurred at Mach 2.0 and to a lesser extent at Mach 1.7. This separation apparently decreased throat bleed effectiveness. Peak pressure recovery for a ramp angle change from 12° to 22° decreased from 0.865 to 0.74 at a Mach number of 2.0, from 0.965 to 0.925 at Mach 1.7, and only from 0.987 to 0.964 at Mach 1.5. Author

**N63-13873** National Advisory Committee for Aeronautics. Langley Aeronautical Lab., Langley Field, Va.

**THE ORIGIN AND DISTRIBUTION OF SUPERSONIC STORE INTERFERENCE FROM MEASUREMENT OF INDIVIDUAL FORCES ON SEVERAL WING-FUSELAGE-STORE CONFIGURATIONS. III—SWEPT-WING FIGHTER-BOMBER CONFIGURATION WITH LARGE AND SMALL STORES. MACH NUMBER, 1.61**

Norman F. Smith and Harry W. Carlson Washington, NACA, Sept. 15, 1955 115 p 4 refs

(NACA RM L55H01) OTS: $9.60 ph, $3.65 mf (Declassified)

A supersonic wind-tunnel investigation of the origin and distribution of store interference has been performed in the Langley 4- by 4-foot supersonic pressure tunnel at a Mach number of 1.61 in which separate forces on a store, a fuselage, a swept wing, and a swept-wing—fuselage combination were measured. The store was separately sting-mounted on its own six-component internal balance and was traversed through a wide systematic range of spanwise, chordwise, and vertical positions. This report presents data on a configuration which simulated a fighter-bomber airplane with a large and a small external store. The interference effects measured for the fighter-bomber configuration were similar in character and magnitude to those reported previously for a heavy-bomber configuration having the same swept wing. Hence, the wing is shown to be the predominant component in the production of interference, with the fuselage secondary. The differences in interference which are measured can be explained in general on the basis of the analysis and force breakdown information presented herein and in NACA Research Memorandums L55A13a and L55E26a. Author

**N63-13879** National Advisory Committee for Aeronautics. Lewis Flight Propulsion Lab., Cleveland, Ohio

**PERFORMANCE OF A BLUNT-LIP SIDE INLET WITH RAMP BLEED, BYPASS, AND A LONG CONSTANT-AREA DUCT AHEAD OF THE ENGINE: MACH NUMBERS 0.66 AND 1.5 TO 2.1**

John L. Allen Washington, NACA, Dec. 28, 1956 54 p 2 refs

(NACA RM E56J01) OTS: $5.60 ph, $1.82 mf (Declassified)

The performance of a side inlet having a fixed 12° two-dimensional compression surface was determined at Mach numbers of 0.66 and 1.5 to 2.1 for a range of angles of attack and yaw. The effects of several methods of compression-surface boundary-layer removal were investigated as well as the effects of a solid ramp. At Mach numbers 2.0 and 1.7 shock-induced separation of the ramp boundary layer became progressively unsteady as mass-flow ratio was reduced and caused a corresponding increase in static-pressure fluctuations at the diffuser exit. Compression-surface bleed reduced and stabilized the shock-induced separation and thus extended the usable range of stable mass-flow ratio. Peak pressure recovery occurred just before minimum stable flow. Of the various types of boundary-layer bleed, external perforations gave the greatest gains in pressure recovery and stability. At Mach 2.0 peak pressure recovery was increased from 0.802 for the solid ramp to 0.89; and stability range, from about 0.10 to 0.285, in terms of mass-flow ratio from the critical value. Distribution and density of perforations were important factors. For the same bleed flow area, external slots were less effective than perforations. Although the stability range was generally smallest for internal bleed, the level of pressure recoveries within the stable region was higher than for external bleed. A 5-diameter constant-area section followed by overexpansion and contraction between the diffuser exit and compressor inlet was very effective in reducing large values of total-pressure distortion for a total-pressure recovery loss of less than 4 percent. With throat bleed, distortion at the diffuser exit was appreciably reduced, and the long duct was less effective. A flush-type bypass near the compressor face tended to offset the total-pressure loss caused by the long duct by removing the boundary layer generated therein. Excellent angle-of-attack characteristics were obtained with both the solid and perforated ramps. Author

**N63-13880** National Advisory Committee for Aeronautics. Langley Aeronautical Lab., Langley Field, Va.

**AERODYNAMIC LOADS ON AN EXTERNAL STORE ADJACENT TO AN UNSWEPT WING AT MACH NUMBERS BETWEEN 0.75 AND 1.96**

William M. Hadaway Washington, NACA, Feb. 17, 1956 62 p 16 refs

(NACA RM L55L07) OTS: $6.60 ph, $2.06 mf (Declassified)

An investigation has been conducted in the 9- by 12-inch blowdown tunnel of the Langley 19-foot pressure tunnel to determine the aerodynamic characteristics of a sting-mounted Douglas Aircraft Company (DAC) store in the presence of, but not attached to, an unswept semispan cantilevered wing of aspect ratio 4.0. The influence of the store on the aerodynamic characteristics of the wing was also obtained. The store was located at two lateral and three vertical positions (with and without pylon) beneath the wing, and tests were conducted at angles of attack from –3° to 12° and at Mach numbers between 0.75 and 1.96. Test Reynolds numbers were between $1.1 \times 10^6$ and $1.5 \times 10^6$. The presence of the store in the vicinity of the wing generally caused small changes in the slopes of the wing normal-force and bending-moment coefficient through the Mach-number range. A rearward shift in wing aerodynamic center occurred at Mach numbers between 0.75 and 1.20. The most critical store loading condition appeared to be due to store side forces, not only because of the magnitude at high angles of attack but also because the force vector was in the direction of least structural strength of the store support. At positive angles of attack, the store side forces were increased when the store was moved to a more outboard spanwise location. The presence of a supporting pylon had very powerful effects on store side-force-coefficient values at moderate and high angles of attack throughout the Mach number range. The pylon increased values of store side-force coefficient variation with angle of attack, $C_{Y_{\beta_w}}$, to approximately twice those for the pylon-off condition with the store axis one-store diameter below the wing. Significant store side-force increments were indicated at supersonic Mach numbers when the store was affected by the interference field propagated from the fuselage nose. Author

**N63-13883** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**AN EXPERIMENTAL INVESTIGATION OF CIRCULAR INTERNAL-COMPRESSION INLETS WITH TRANSLATING CENTERBODIES EMPLOYING BOUNDARY-LAYER REMOVAL AT MACH NUMBERS FROM 0.85 TO 3.50**

Frank A. Pfyl and Earl C. Watson Washington, NASA, Mar. 1959 71 p 12 refs

(NASA MEMO 2-19-59A) OTS: $7.60 ph, $2.33 mf (Declassified)

The performance characteristics of axially symmetric internal-compression inlets with translating centerbodies are presented for a Mach number range of 0.85 to 3.5 and for Reynolds numbers between 0.6 and 5.2 million (based on inlet diameter). The study chiefly concerns the effect of boundary-layer removal on the total-pressure recovery for a number of internal shapes. A limited amount of data

shows the effect of flow-deflector plates on angle-of-attack performance and data showing inlet flow distortion and unsteadiness characteristics also are included. The results of the investigation showed that at Mach number 2.5 the pressure recovery of a straight inlet with zero boundary-layer removal was 76 percent, whereas, with boundary-layer removal equal to approximately 8 percent of the entering inlet mass flow the pressure recovery was 88 percent. Although different in internal shape, the best straight and isentropic inlets had approximately the same pressure recovery at Mach number 2.5 when boundary-layer bleed was applied. However, in the case of the ogival inlet the pressure recovery was poorer than that of the straight and isentropic inlets. The initial rate of pressure recovery decay with angle of attack for the straight inlets increased with increasing Mach number. With one inlet, a flow deflector plate was effective in maintaining the pressure recovery up to at least 9° angle of attack, and it improved the total-pressure distribution. A study of the internal-pressure oscillations on two of the straight inlets showed that no airflow unsteadiness occurred during supercritical inlet operation (terminal shock inside inlet). A test with one inlet indicated that the maximum obtainable pressure recovery generally increased with increasing values of Reynolds number from 2.7 to 5.2 million. Author

**N63-13888** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

**PERFORMANCE OF A MACH NUMBER OF 3.0 DESIGN AXISYMMETRIC DOUBLE-CONE EXTERNAL-COMPRESSION INLET IN MACH NUMBER RANGE 2.07 TO 1.48**

John L. Allen and Glenn A. Mitchell Washington, NASA, Jan. 1959 38 p 3 refs
(NASA MEMO 12-22-58E) OTS: $3.60 ph, $1.34 mf (Declassified)

An axisymmetric double-cone external-compression inlet having a known performance from Mach number 3.0 to 2.0 was investigated at Mach numbers 2.07 to 1.48 and 0.7. Several spike positions were tested at angles of attack as high as 15°. First- and second-cone half-angle combinations of 20° and 35°, as well as 25° and 35°, were tested. The performance of a throat ram-scoop boundary-layer bleed developed for Mach number 3.0 for the 20°-35° centerbody was also determined. At Mach number 1.98, the supercritical external drag coefficient was 3.1 and 2.75 times the Mach number 3.0 value for the fixed- and retracted-spike positions, respectively. Similar numbers for Mach number 1.48 were: 3.85 for the Mach number 3.0 spike position and 3.25 for the retracted. Peak total-pressure recovery was not consistently higher for any configuration or spike position. The level of peak recovery varied from 0.88 to 0.915 at Mach number 2.07 and from 0.945 to 0.99 at Mach number 1.48. Both diffuser-exit flow distortion and peak recovery were significantly less sensitive to angle-of-attack effects when the spike was in a retracted position (limited by internal contraction) as contrasted with the spike position for Mach number 3.0. Author

**N63-13889** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**SUBSONIC AERODYNAMIC CHARACTERISTICS OF SEVERAL BLUNT, LIFTING, ATMOSPHERIC-ENTRY SHAPES**

Howard F. Savage and Bruce E. Tinling Washington, NASA, Jan. 1959 32 p 2 refs
(NASA MEMO 12-24-58A) OTS: $3.60 ph, $1.16 mf (Declassified)

The subsonic aerodynamic characteristics of some possible atmospheric-entry configurations have been determined from wind-tunnel tests. The basic shape was formed by removal of a portion of a blunted 60° cone to form a flat-topped lifting body. Modifications to this body were investigated in regard to obtaining stability and control. These modifications included changes in base shape, rounding of the upper-surface edges, addition of a low-aspect-ratio wing, and addition of control surfaces. The results indicate that both winged and wingless blunt vehicles can be made stable at subsonic speeds for moment center locations compatible with hypersonic stability and control requirements. Author

**N63-13892** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**TRANSONIC STATIC AERODYNAMIC CHARACTERISTICS OF A BLUNT CONE-CYLINDER BODY WITH FLARED AFTERBODIES OF VARIOUS ANGLES AND BASE AREAS**

Roy M. Wakefield, Earl D. Knechtel, and Stuart L. Treon Washington, NASA, Dec. 1959 45 p 8 refs
(NASA TM X-106) OTS: $4.60 ph, $1.55 mf (Declassified)

A transonic wind-tunnel investigation has been conducted to determine the static aerodynamic characteristics of a low-fineness-ratio blunt cone-cylinder stabilized by various flared afterbodies. The effects of variation of the ratio of flare base area to body cross-sectional area are shown for three flare angles. Test Mach numbers ranged from 0.60 to 1.40 and angles-of-attack from -2° to + 14°, for a constant Reynolds number of 0.375 million based upon the cylindrical body diameter. Author

**N63-13895** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**AN EXPERIMENTAL INVESTIGATION AT MACH NUMBERS FROM 2.1 TO 3.0 OF CIRCULAR INTERNAL-COMPRESSION INLETS HAVING TRANSLATABLE CENTERBODIES AND PROVISIONS FOR BOUNDARY-LAYER REMOVAL**

Earl C. Watson Washington, NASA, Jan. 1960 27 p 2 refs
(NASA TM X-156) OTS: $2.60 ph, $1.01 mf (Declassified)

An experimental investigation was conducted to determine the effects of boundary-layer removal on the characteristics of four internal-compression inlets. Each of the inlets had approximately the same shape and differed primarily in the extent of the regions of perforations which were employed in the internal surfaces to permit the removal of boundary-layer air. Each inlet was axially symmetric and had a translatable centerbody which permitted the contraction ratio to be varied to as low as 0.251 for two of the inlets investigated. In addition, the internal surfaces were shaped to provide a nearly constant-area throat region for all centerbody positions. The length from the inlet entrance to the compressor station was 4.8 inlet entrance diameters. Data were obtained at 0° angle of attack for Mach numbers from 2.1 to 3.0 and for corresponding Reynolds numbers (based on inlet-entrance diameter) from 3.6 to 5.1 million. Results showed that boundary-layer removal through a perforated area in the annulus and centerbody having a total open area equal to 0.105 of the inlet entrance area and located downstream of the minimum flow area increased the total-pressure recovery between 3 and 5 percent in the Mach number range from 2.5 to 2.9, the limit for comparison. The amount of boundary-layer air removed was estimated to be between 7 and 9 percent of the inlet mass flow. By extending the perforated area ahead of and behind the throat region, the total-pressure recovery was further increased. However, the amount of flow removed to obtain this improvement could not be determined accurately. For this latter configuration, the total-pressure recovery was 0.87 and 0.75 at Mach numbers of 2.5 and 3.0, respectively. Author

**N63-13896** National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.

**TRANSONIC OFF-DESIGN PERFORMANCE OF A FIXED DIVERGENT EJECTOR DESIGNED FOR A MACH NUMBER OF 2.0**

Harry T. Norton, Jr., Marlow D. Cassetti, and Charles E. Mercer Washington, NASA, Dec. 1959 63 p 8 refs
(NASA TM X-165) OTS: $6.60 ph, $2.09 mf (Declassified)

An investigation of a pylon-supported nacelle model with a fixed divergent ejector has been conducted in the Langley 16-foot transonic tunnel over a Mach-number range from 0.90 to 1.06. The divergent ejector was designed for a Mach number of 2.0 and a primary jet total-pressure ratio of 10.1, with an afterburning primary nozzle and a corrected secondary weight-flow ratio of 0.042. The jet exhaust was simulated with a hydrogen peroxide turbojet simulator. The average Reynolds number based on nacelle length was 20 x 10⁶. The results of the investigation indicate that, for values of primary

total-pressure ratio and corrected weight-flow ratio corresponding to a typical turbojet-engine schedule, satisfactory performance was obtained with the nonafterburning nozzle configuration over the Mach number range from 0.90 to 1.00. However, the nonafterburning configuration experienced a large loss in performance when the primary jet total-pressure ratio was equal to a value for which the jet was just attached to the divergent wall of the ejector. The afterburning nozzle configuration experienced large off-design losses in performance over the Mach-number range of the investigation due to overexpansion of the primary jet. Author

**N63-13899** National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

**FLIGHT TESTS OF A TWIN-DUCT INDUCTION SYSTEM FOR A MACH NUMBER RANGE OF 0.78 TO 2.07**

Jack Nugent and Bruce G. Powers Washington, NASA, Sept. 1960 44 p 9 refs

(NASA TM X-281) OTS: $4.60 ph, $1.52 mf (Declassified)

Flight tests of a twin-duct induction system over a Mach number range from about 0.78 to about 2.07 during quasi-steady operation indicated that in the Mach number range from about 1.05 to about 1.55 the 40,000-foot data exhibited about a 1½-percent higher total-pressure recovery than did the 26,000-foot data. This result was obtained for very similar subcritical shock-wave configuration and identical bypass configuration at trim angle of attack. The 26,000-foot data showed significantly lower distortion, however. A total-pressure recovery of about 95 percent and a distortion parameter of about 15 percent were noted for the 40,000-foot data at a Mach number of 1.55. The 40,000-foot data and 55,000-foot data showed essentially the same recovery for very similar shock-wave configuration and an increased bypass configuration at trim angle of attack. A value of about 81 percent was noted for a Mach number of 2.05 for both sets of data. A distortion of 33 percent was obtained for the 55,000-foot data at a Mach number of about 1.24 during supercritical operation. At a Mach number of 1.7, area-weighted pressure recovery decreased from about 91 percent to about 88 percent as angle of attack increased from 3° to 7°, whereas the distortion parameter decreased from 19 percent to 15 percent as angle of attack increased above 2°. Angle of attack produced only slight effects at lower Mach numbers. Local total-pressure recovery exhibited symmetry about the vertical center line of the engine face for all data. Highest total-pressure recovery was obtained at the 3 o'clock and 9 o'clock rake positions, with lowest recovery obtained at the bottom of the duct during level flight. For the same Mach number all test data showed essentially the same cone-pressure profiles. Shock-boundary-layer interaction along the cone surface occurred for the 40,000-foot data and the 55,000-foot data for Mach numbers of 1.5 and greater. This result affected the cone-surface pressure distribution. During ground-run operation, a recovery of about 88 percent and a distortion parameter of 10 percent were obtained for maximum engine demand. Author

**N63-13911** National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.

**INVESTIGATION OF THE NORMAL-FORCE, AXIAL-FORCE, AND PITCHING-MOMENT CHARACTERISTICS OF BLUNT LOW-FINENESS-RATIO BODIES OF REVOLUTION AT A MACH NUMBER OF 3.55**

Russell W. Mc Dearmon and Warren A. Lawson Washington, NASA, Apr. 1961 32 p 13 refs

(NASA TM X-467) OTS: $3.60 ph, $1.16 mf (Declassified)

An investigation of the normal-force, axial-force, and pitching-moment characteristics of blunt, low-fineness-ratio bodies of revolution has been made at a Mach number of 3.55. The results indicate that, for cylinders having fineness ratios of 1.00 and 0.50, rounding the corners of the noses caused large decreases in the axial-force coefficients, moderate increases in the slopes of the normal-force curves, and very small changes in the slopes of the pitching-moment curves. Varying the half-angles of cylinder-cone frustrums and spherical-faced cone frustums had large effects on the axial-force coefficients and static stability in pitch. For exponential shapes, increasing the exponent from 2 to 10 generally increased the axial-force coefficients, decreased the slopes of the normal-force curves, and decreased the stability in pitch. For a fineness ratio of 1.00 a parabolic body had the least drag, and for a fineness ratio of 0.50 an exponential shape having an exponent of 3 had the least drag. A 26.6° cone and the parabolic body having a fineness ratio of 1.00 had the highest values of normal-force curve slope. All the bodies were statically stable in pitch about a point one-third of the body length rearward from the face, and a spherical-faced cone frustum was the most stable body in pitch. Little variation of axial-force coefficient with angle of attack was obtained for any of the bodies. Theoretical axial-force and normal-force coefficients were obtained for most of the bodies tested by integrating modified Newtonian pressure distributions on the bodies. Comparisons with the experimental results showed that these predictions were accurate for the parabolic bodies, hemisphere, and hemisphere-cylinder. However, poor agreement between experiment and theory was obtained for the very blunt shapes, such as the flat-faced cylinders and the exponential shapes having exponents of 10, where corner effects were not adequately accounted for in the theory. Author

**N63-14029** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**AN EXPERIMENTAL EVALUATION OF AERODYNAMIC DAMPING MOMENTS OF CONES WITH DIFFERENT CENTERS OF ROTATION**

William R. Wehrend, Jr. Washington, NASA, Mar. 1963 52 p 4 refs

(NASA TN D-1768) OTS: $1.50

The static and dynamic stability characteristics of a 12½° semivertex angle cone were studied. The cone was tested with both sharp and blunt tips and with a flat base and spherical segment afterbodies. The tests were performed at Mach numbers from 0.25 to 2.20 for angles-of-attack from −13° to +18°. The Reynolds number varied from 0.68 million to 1.54 million based on model base diameter. Presented are measurements of the normal force, axial force, base pressure, and pitching moment from the static tests, and the damping-in-pitch moment from the dynamic tests. The reduced frequency varied from 0.013 to 0.133 during the oscillatory tests. Author

**N63-14175** Princeton U., N. J.

**THE FLOW OVER A CYLINDER WITH VARIOUS NOSE SHAPES AT ZERO ANGLE OF ATTACK AT HYPERSONIC SPEEDS**

C. C. Horstman Wright-Patterson AFB, Ohio, Aeronautical Research Labs., Jan. 1963 39 p 18 refs

(Contract AF 33(616)-7629)

(ARL-63-14)

As part of a fundamental study of hypersonic wings and control surfaces, some detailed pressure-distribution and heat-transfer results have been obtained about a circular cylinder at zero angle-of-attack and with various nose shapes. The tests were conducted in the Princeton University helium hypersonic wind tunnel at a Mach number of 11. A review and extension of several theories for predicting both pressure and heat transfer is presented. The effects of the various nose shapes used (cone, hemisphere, and flat face) have been determined up to 16 cylinder diameters back from the nose. Author

**N63-14212** Boeing Scientific Research Labs., Seattle, Wash.

**A STUDY OF OPTIMUM SLENDER BODIES IN HYPERSONIC FLOW WITH A VARIABLE FRICTION COEFFICIENT**

Angelo Miele and Julian Cole Jan. 1963 38 p 7 refs

(Tech. Rept. 66; DI-82-0223)

This paper considers the problem of minimizing the total drag of a slender two-dimensional or axisymmetric body of given length and

diameter in hypersonic flow under the assumption that the distribution of pressure coefficients is Newtonian and that the distribution of friction coefficients versus the abscissa is represented by a power law. For the two-dimensional problem, the extremal arc is a wedge regardless of the amount of friction drag and the way it is distributed along the contour. For the axisymmetric problem, the extremal arc includes at most two subarcs, one of which is called the regular shape and the other, the spike of zero-thickness. Furthermore, the solution depends strongly on the friction parameter $K_f$, a parameter which is proportional to the cubic root of the average friction coefficient divided by the thickness ratio. Author

# 03 AERODYNAMICS OF WINGS, ROTORS, AND CONTROL SURFACES

Includes: ailerons; airfoil sections; cascades; fans; flaps; propellers; rotors; slats; spoilers; etc.

*For related information see:* 02 Aerodynamics of Bodies, Combinations, and Internal Flow; and 11 Fluid Mechanics.

**N63-13866** National Advisory Committee for Aeronautics. Langley Aeronautical Lab., Langley Field, Va.

**ROCKET-MODEL INVESTIGATION OF THE ROLLING EFFECTIVENESS OF A FIGHTER-TYPE WING-CONTROL CONFIGURATION AT MACH NUMBERS FROM 0.6 TO 1.5**

H. Kurt Strass and Edward T. Marley Washington, NACA, Feb. 25, 1952 36 p 3 refs

(NACA RM L51128) OTS: $3.60 ph, $1.28 mf (Declassified)

An investigation of the rolling effectiveness of spoiler and aileron aerodynamic controls on a fighter-type airplane has been conducted at Mach numbers from 0.6 to 1.5 by the Langley Pilotless Aircraft Research Division by utilizing rocket-propelled test vehicles. No effects of mutual interference between the midspan spoiler and the outboard aileron were detectable. Above the speed of sound, the ailerons were relatively ineffective as compared with the spoiler, because of wing twisting. For conditions of equal rolling effectiveness, the twisting-moment coefficient of the aileron was approximately three times that of the spoiler. Author

**N63-13867** National Advisory Committee for Aeronautics. Langley Aeronautical Lab., Langley Field, Va.

**FREE-FLIGHT TESTS OF 45° SWEPT WINGS OF ASPECT RATIO 3.15 AND TAPER RATIO 0.54 TO MEASURE WING DAMPING OF THE FIRST BENDING MODE AND TO INVESTIGATE THE POSSIBILITY OF FLUTTER AT TRANSONIC SPEEDS**

Burke R. O'Kelly, Reginald R. Lundstrom, and William T. Lauten, Jr. Washington, NACA, Oct. 12, 1954 25 p 3 refs

(NACA RM L54C22) OTS: $2.60 ph, $0.95 mf (Declassified)

Free-flight tests have been made on two pairs of wings of aspect ratio 3.15, taper ratio 0.54, and 45° sweepback in the transonic-speed range to measure wing damping and to investigate the possibility of flutter. The first bending and torsional frequencies for the first model were 37 and 148 cycles per second, and the corresponding values for the second model were 31 and 122 cycles per second. The mass ratio of the wings was similar to that of current fighter-type wings at about 30,000 feet. Flutter did not occur during either flight. The maximum Mach number of the first model was 1.50, and for the second model the maximum Mach number was 1.39. One pair of wings was equipped with small devices to excite the bending mode of the wings and the total damping was measured from the resulting oscillations. Author

**N63-13884** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**WIND-TUNNEL INVESTIGATION OF DEVICES TO IMPROVE STATIC DIRECTIONAL STABILITY OF AN UNSWEPT-WING AIRPLANE MODEL AT MACH NUMBERS FROM 0.8 TO 2.2**

Ralph W. Holtzclaw Washington, NASA, Dec. 1958 45 p 7 refs

(NASA MEMO 10-4-58A) OTS: $4.60 ph, $1.55 mf (Declassified)

Experimental results are presented showing the effects of increased vertical-tail chord, two sizes of ventral fins, and two sizes of double ventral fins in an inverted V arrangement on the static directional stability characteristics of a model of a fighter-type airplane at Mach numbers from 0.8 to 2.2. The model incorporated an unswept wing of low aspect ratio, a horizontal tail mounted high on the vertical tail, and airflow through the fuselage side inlets. Also included are the static longitudinal stability and drag characteristics and the effects of an enlarged canopy on the stability and drag characteristics. The directional stability of the model decreased rapidly with either increasing supersonic Mach number or angle of attack. A major portion of the directional stability contribution of the vertical tail was required to overcome the unstable yawing moment of the body. Neither the increased vertical-tail chord nor the ventral fins eliminated the directional instability at angles of attack above 19° at a Mach number of 2.0. The increased vertical-tail chord caused the greatest increase of angle of attack for the onset of directional instability, 3°, and the maximum increase of directional stability per unit of added surface area. Use of the tail with increased chord in conjunction with the small single ventral fin more than doubled the directional stability of the configuration at a Mach number of 2.0 at an angle of attack of 2.5°. The results indicated a region of reduced longitudinal stability at Mach numbers of 2.0 and above at lift coefficients below about 0.3 and a characteristic decrease in longitudinal stability at high angles of attack at all Mach numbers. Author

**N63-13897** National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.

**USE OF EXPERIMENTAL STEADY-FLOW AERODYNAMIC PARAMETERS IN THE CALCULATION OF FLUTTER CHARACTERISTICS FOR FINITE-SPAN SWEPT ON UNSWEPT WINGS AT SUBSONIC, TRANSONIC, AND SUPERSONIC SPEEDS**

E. Carson Yates, Jr. Washington, NASA, Jan. 1960 52 p 15 refs

(NASA TM X-183) OTS: $5.60 ph, $1.76 mf (Declassified)

Flutter calculations for several swept and unswept wings through the transonic speed range have been made by the modified strip-theory method of NACA RM L57L10, which employs steady-flow aerodynamic parameters for the undeformed wing. Experimentally determined distributions of steady-flow aerodynamic parameters for the undeformed wings were used in the present calculations. Comparisons of these calculated results with experimental flutter data and with calculations previously made by using linearized-theory aerodynamic parameters indicate that the method employed gives accurate flutter results for swept wings at subsonic, transonic, and supersonic speeds. However, since this method of flutter calculation is not applicable when the Mach number component normal to the leading edge is near 1.0, it appears that the transonic flutter characteristics of unswept wings cannot be calculated by the method as given in NACA RM L57L10. An attempt was made to remove this limitation by using experimental values of two-dimensional lift-curve slope (instead of theoretical values) in the calculation of circulation functions when the Mach number component normal to the leading edge was near 1.0. Applying this procedure to two unswept wings removed the spurious asymptotic rise of flutter speed near Mach number 1.0, but it did not result in very close agreement between calculated and experimental flutter speeds. The possibility of obtaining estimates of flutter characteristics for unswept wings by use of total aerodynamic parameters has also been examined. Although no supersonic calculations were made using total aerodynamic parameters, it appears that the procedure outlined gives reasonable estimates of flutter characteristics at subsonic speeds. Author

**N63-13898** National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.

**EXPERIMENTAL INVESTIGATION OF A TRANSONIC COMPRESSOR CASCADE AND TEST RESULTS FOR FOUR BLADE SECTIONS**

James C. Emery, James C. Dunavant, and Willard R. Westphal Washington, NASA, Jan. 1960 44 p 5 refs
(NASA TM X-197) OTS: $4.60 ph, $1.52 mf (Declassified)

This investigation describes the development of a transonic compressor cascade and includes test results for four blade sections over a range of Mach number from 0.7 to 1.4. The results indicate that a transonic cascade is practical and will give much needed information applicable to compressor design. Cascade pressure rise is shown to be in agreement with the single-rotor test point which is available. Author

**N63-13901** National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.

**AERODYNAMIC HEATING TESTS OF MISSILE STABILIZERS IN A FREE JET AT MACH NUMBER 2**

Louis F. Vosteen Washington, NASA, Sept. 1960 34 p 2 refs
(NASA TM X-299) OTS: $3.60 ph, $1.22 mf (Declassified)

Results are presented for tests of seven missile stabilizers subjected to aerodynamic heating in a Mach-number-2 blowdown wind tunnel. The stabilizers had the same planform, but differed in the material used for cover skins and in the internal frame construction. Some stabilizers employed fillers of either an aluminum honeycomb or a urethane foam. Stabilizers which had metal skins (either aluminum or magnesium alloys) were more susceptible to failures in the bond between skin and frame than models covered with a Fiberglas laminate. Author

**N63-14115** Massachusetts Inst. of Tech., Cambridge

**DIVERGENCE AND REVERSAL OF CONTROL**

Kenneth A. Foss *In* Advisory Group for Aeronautical Research and Development, Paris (France) Manual on Aeroelasticity. Part V. Factual Information on Flutter Characteristics [1961] 14 p 27 refs (See N63-14113 09-01)

An enumeration of the static aeroelastic phenomena likely to be encountered by modern airplanes, and a description of means by which adverse aeroelastic effects can be prevented or alleviated include: (1) effects of compressibility and wing sweep on dynamic pressure at divergence; (2) aeroelastic effects of compressibility and wing sweep on wing root bending moments; (3) effects of compressibility and wing sweep on dynamic pressure at aileron reversal; (4) aeroelastic effects of compressibility and wing sweep on lateral control and rolling maneuverability; and (5) wing configurations which alleviate adverse static aeroelastic effects. I.v.L.

## 04 AIRCRAFT

Includes: specific types of complete aircraft (e.g., Ground Effects Machines, Flexible Wings, STOL, and VTOL); flight tests; operating problems; stability and control.

*For related information see:* 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings, Rotors, and Control Surfaces; and 30 Space Vehicles.

**N63-13798** Martin Co., Orlando, Fla.

**RECIRCULATION PRINCIPLE FOR GROUND EFFECT MACHINES—MAN-CARRYING TEST VEHICLE AND COMPONENT TESTING [Interim Report]**

J. Butsko, R. Reiland, B. Robinson, and C. Middlebrooks Ft. Eustis, Va., Army Transportation Research Command, Feb. 1963 47 p 3 refs
(Contract DA-44-177-TC-710)
(TCREC-TR-62-99)

This report describes the design and construction of a research vehicle utilizing recirculating ejectors for the lift system. The design, fabrication, and installation of the powerplant, recirculating ejector system, primary structure, pneumatic duct system, and control system are discussed in detail, and an overall description of the vehicle is presented. A hover height of one foot and a weight/power ratio of 8 to 10 were the basic performance objectives which governed the design philosophies and considerations. The initial purpose of the man-carrying test vehicle is to evaluate the hovering performance, stability, and control of a vehicle using annular recirculation. Author

**N63-13864** National Advisory Committee for Aeronautics. Ames Aeronautical Lab., Moffett Field, Calif.

**WIND-TUNNEL INVESTIGATION AT SUBSONIC AND SUPERSONIC SPEEDS OF A MODEL OF A TAILLESS FIGHTER AIRPLANE EMPLOYING A LOW-ASPECT-RATIO SWEPT-BACK WING-STABILITY AND CONTROL**

Willard G. Smith Washington, NACA, Jan. 12, 1953 52 p 7 refs
(NACA RM A52J30) OTS: $5.60 ph, $1.76 mf (Declassified)

This report presents the results of a wind-tunnel investigation of the static stability and control characteristics of a model of a fighter airplane employing a low-aspect-ratio sweptback wing with trailing-edge elevons, a sweptback vertical tail, but no horizontal tail. The investigation was conducted over a Mach number range of 0.60 to 0.90 and 1.20 to 1.70, at constant Reynolds numbers of 2.0 million for the stability tests and 3.2 million for the control effectiveness tests. All results are presented in tabular form and typical data are presented in graphic form as well. The results indicate that, for the test conditions at which the investigation was conducted, the model, with elevons undeflected, was longitudinally and directionally stable. Sufficient control effectiveness was provided by the trailing-edge elevons to permit longitudinal balance of the model to a lift coefficient of 0.44 at a Mach number of 0.90, and to lift coefficients of 0.25 and 0.11 at Mach numbers of 1.20 and 1.70, respectively. With the rudder deflected 8° and the model at an angle-of-attack of −0.5°, the results indicate that the model will have sufficient directional control to maintain sideslip angles of 3.6° at 0.90 Mach number and 2.3° at 1.40 Mach number. Author

**N63-13881** National Advisory Committee for Aeronautics. Ames Aeronautical Lab., Moffett Field, Calif.

**AERODYNAMICS OF MISSILES EMPLOYING WINGS OF VERY LOW ASPECT RATIO**

Elliott D. Katzen and Leland H. Jorgensen Washington, NACA, Mar. 5, 1956 15 p 9 refs
(NACA RM A55L13b) OTS: $1.60 ph, $0.80 mf (Declassified)

The principal results of an investigation to determine the aerodynamic characteristics of missiles employing wings of very low aspect ratio are presented. The performance and stability and control characteristics of the missiles are discussed. Author

**N63-13885** National Aeronautics and Space Administration. High-Speed Flight Station, Edwards, Calif.

**LIFT AND DRAG OF A SWEPT-WING FIGHTER AIRPLANE AT TRANSONIC AND SUPERSONIC SPEEDS**

Jack Nugent Washington, NASA, Jan. 1959 32 p 5 refs
(NASA MEMO 10-1-58H) OTS: $3.60 ph, $1.16 mf (Declassified)

A flight investigation was made of the lift and drag of a swept-wing fighter airplane in the basic configuration and in a slats-locked-closed configuration over a Mach number range from about 0.63 to about 1.44. At a nominal lift coefficient of 0.1, negligible drag-coefficient difference existed between the two configurations over a comparable Mach-number and altitude range. For the basic configuration

at zero lift, the supersonic drag level was about three times as great as the subsonic drag level, which was about 0.01, whereas the drag-due-to-lift factor increased about 137 percent over the test Mach-number range. At comparable Mach numbers, the high-altitude data produced a larger lift-curve slope and showed a more pronounced variation of lift-curve slope in the transonic region than did the low-altitude data. For the high-altitude data, the lift-curve slope at a Mach number of 1.44 was approximately 62 percent of the value at a Mach number of 0.9. Author

**N63-13886** National Aeronautics and Space Administration. High-Speed Flight Station, Edwards, Calif.

**FLIGHT-DETERMINED STABILITY AND CONTROL DERIVATIVES OF A SUPERSONIC AIRPLANE WITH A LOW-ASPECT-RATIO UNSWEPT WING AND A TEE-TAIL**

William H. Andrews and Herman A. Rediess Washington, NASA, Apr. 1959 40 p 14 refs
(NASA MEMO 2-2-59H) OTS: $3.60 ph, $1.40 mf (Declassified)

A flight-test investigation of a supersonic airplane with a low-aspect-ratio unswept wing provided data in the trim angle-of-attack range for obtaining the longitudinal, lateral, and directional stability and control derivatives between Mach numbers of 0.88 and 2.08. The longitudinal-stability and three-axes control derivatives were determined by somewhat standard simplified methods, whereas the time-vector method was employed in the analysis of the lateral and directional stability derivatives. The general correlation of the flight-determined derivatives with wind-tunnel results was good, except for a discrepancy in the absolute level of the effective dihedral derivative and the damping-in-roll derivative. An improvement of approximately 10 to 15 percent in the static directional stability was realized in the supersonic speed range by the installation of a ventral fin on the airplane. In the region between a Mach number of 1.38 and 1.43, an abrupt loss in the directional damping to slightly unstable conditions was experienced. At Mach numbers greater than 1.43, the damping was relatively low, but positive. The application of the time-vector method of analysis to determine the lateral and directional derivatives was modified by incorporating the yawing velocity as a reference instead of the usual sideslip angle. This modification tended to improve the reliability and reduce the labor involved in utilizing the method. Author

**N63-13894** National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

**APPROACH AND LANDING INVESTIGATION AT LIFT-DRAG RATIOS OF 3 TO 4 UTILIZING A DELTA-WING INTERCEPTOR AIRPLANE**

Gene J. Matranga and Joseph A. Menard Washington, NASA, Oct. 1959 24 p 3 refs
(NASA TM X-125) OTS: $2.60 ph, $0.92 mf (Declassified)

A series of landings was performed with a delta-wing interceptor airplane to evaluate the effect of low lift-drag ratios on approach and landing characteristics. Landings with peak effective lift-drag ratios as low as 3.75 were made by altering the airplane configuration (reducing the throttle setting to idle, and extending speed brakes, missile-bay doors, and gear). The altitude, indicated airspeed, vertical velocity, and flight-path angle at the initiation of flare, and the time to flare increased noticeably with the reduction in lift-drag ratio. However, the pilots reported that all approaches and landings were comfortable, with ample time and control available for any required corrections. A comparison of the data from these tests with the results of tests made on a straight-wing fighter airplane having twice the wing loading shows that the data are similar, but with several notable exceptions. The speeds for the delta-wing interceptor were markedly slower, the high key point (initial point) was considerably lower, the pattern was much tighter, and the flight-path angles at the initiation of flare were higher than for the straight-wing airplane which had a greater wing loading. Pilot comment indicated that the subject airplane was more comfortable than the straight-wing airplane in the approach pattern for the same lift-drag ratio, but that the airplanes exhibited similar characteristics during the flare. When flying specific calculated landing patterns, the pilot reported difficulty in determining the initial point accurately without external guidance; however, he was successful in locating the initial point during these landings and indicated that the patterns were easy and comfortable to fly. Author

**N63-13902** National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.

**INVESTIGATION OF THE STATIC LONGITUDINAL STABILITY CHARACTERISTICS OF AN AIR-TO-SURFACE CANARD MISSILE CONFIGURATION IN THE TRANSONIC MACH NUMBER RANGE**

Gerald L. Hunt Washington, NASA, Oct. 1960 20 p 1 ref
(NASA TM X-305) OTS: $1.60 ph, $0.80 mf (Declassified)

The static longitudinal stability and control characteristics of a canard missile configuration were investigated in the Langley 8-foot transonic tunnel to obtain the variation of the longitudinal stability parameter $(dC_m/dC_L)_{trim}$ with Mach number and canard deflection in the transonic Mach-number range. Data indicated that the configuration became progressively more stable in the trim lift-coefficient range with an increase in horizontal canard deflection to 20°. It was also evident that the parameter $(dC_m/dC_L)_{trim}$ showed the least variation with Mach number for canard deflections of 5° and 10°. Author

**N63-13912** National Aeronautics and Space Administration. Flight Research Center, Edwards, Calif.

**SKIN AND STRUCTURAL TEMPERATURES MEASURED ON THE X-15 AIRPLANE DURING A FLIGHT TO A MACH NUMBER OF 3.3**

Robert D. Reed and Joe D. Watts Washington, NASA, Jan. 1961 24 p 1 ref
(NASA TM X-468) OTS: $2.60 ph, $0.92 mf (Declassified)

A survey of skin and structural temperatures was obtained on the X-15 airplane during a flight to a Mach number of 3.3. Fuselage, wing, horizontal-tail, and vertical-tail temperatures are presented to show temperature variations on the external surfaces and temperature differences between the skin and internal structure. The maximum temperature recorded was 440° F on an unsupported skin area on the lower vertical tail. Temperature differences of 400° F were recorded between the external skin and internal spar webs on the wing. Local external temperature differences caused by the heat-sink effect of the supporting structure were as great as 220° F. Temperature-indicating paint aided in identifying the location of areas of concentrated heating on the lower surface of the wing. Author

**N63-13971** Aeronautical Research Inst. of Sweden, Stockholm

**INTERNATIONAL LONG-TERM PLANNING AIMING TO LIMIT AIRPORT NOISE**

Bo K. O. Lundberg 1962 12 p 2 refs Paper presented at the Second Intern. Congress of the Intern. Association to Limit Noise, Salzburg, May 16-18, 1962
(FFA-MEMO-PE-13)

The main difficulties in limiting airport noise lie in the facts: (a) that it is not only the maximum noise levels caused by takeoff that cause annoyance and complaints; the number of noise occurrences, both of maximum and lower levels, as well as the duration of each noise occurrence contribute to the total noise disturbance; and, (b) that there is in general no real incentive for the manufacturers to reduce the noise level of new aircraft types apart from keeping below a certain, usually very high, maximum value. On the basis of an assumed relationship regarding the distrubance effect caused by noise occurences of various peak noise levels, a proposal is made with the aim of limiting airport noise all over the world. The main points are that the aircraft should be classified in noise classes indicating noisiness, that the airports should be classified in noise classes

indicating noise sensitivity and that an international airport noise register should be kept, giving information, for each airport, about, *inter alia*, noise class and the time when noise saturation is expected to occur as estimated on the basis of the relationship between the number of noise occurrences and their noise levels. The proposal is believed to overcome the two main difficulties indicated. The main advantages are thought to be that both the manufacturers and the operators would have a direct quantitatively determinable interest in a development aiming at more and more quiet aircraft, i.e., at reducing the noise "at the source", and that, in the planning of new airports, the noise factor could be taken into account on a quantitative basis so as to enable the community to weigh the great advantage of a nearby airport against a predictable maximum noise disturbance around the airport. Author

**N63-13972** Aeronautical Research Inst. of Sweden, Stockholm
**NOTES ON THE LEVEL OF SAFETY AND THE REPAIR RATE WITH REGARD TO FATIGUE IN CIVIL AIRCRAFT STRUCTURES—BASED ON GENERAL VIEWS REGARDING SAFETY IN AVIATION**
Bo K. O. Lundberg 1962 35 p 15 refs Presented at the Eleventh Tech. Conf. of Intern. Air Transport Association, Monte Carlo, Sept. 8-13, 1958
(FFA-MEMO-PE-15; Previously issued as Tech. Note HE-794)

Among the various methods available to define the level of safety with respect to fatigue in aircraft structures, the aircraft failure rate per hour is concluded to be preferable. It is judged from a study of the future development of civil aviation and its implications with respect to safety in aviation, that the failure rate of the primary aircraft structure due to fatigue should not exceed the magnitude of $10^{-9}$ per hour. The total failure rate should be subdivided by the designer and allotted to 1) the safe-life and fail-safe principles—if both are employed—and 2) the various structural components. The fail-safe and safe-life concepts are defined and two criteria, the "fail-safe-load" criterion and the "critical number of part failures" criterion, to be complied with for fail-safe design, are discussed in detail. In order to stress the importance of the large number of fatigue-sensitive spots in an aircraft structure, a numerical example is given for a pressure cabin. It is emphasized that the frequency of inspections necessary to provide a fail-safe structure with a sufficient and known safety level must be based on statistical considerations and therefore cannot be rationally established without a numerically expressed goal for the safety level, such as the one proposed. If such a goal is not fixed and applied, complete uncertainty will prevail with regard to the fatigue safety level. It is then feared that catastrophic accidents due to fatigue, in spite of extensive application of fail-safe design, will be more frequent than would be tolerable to the public, although this would not become evident until a great number of existing and new transport aircraft have been in service for a considerable time. Author

**N63-14185** Martin Co., Orlando, Fla.
**RECIRCULATION PRINCIPLE FOR GROUND EFFECT MACHINES MAN-CARRYING TEST VEHICLE AND COMPONENT TESTING [Interim Report] July 1961 to April 1962**
J. Butsko, R. Reiland, B. Robinson, and C. Middlebrooks Ft. Eustis, Va., Army Transportation Research Command Feb. 1963 47 p 3 refs
(Contract DA-44-177-TC-710)
(TCREC-TR-62-99)

This report describes the design and construction of a research vehicle utilizing recirculating ejectors for the lift system. The design, fabrication, and installation of the powerplant, recirculating ejector system, primary structure, pneumatic duct system, and control system are discussed in detail and an overall description of the vehicle is presented. A hover height of one foot and a weight/power ratio of 8 to 10 were the basic performance objectives which governed the design philosophies and considerations. The initial purpose of the man-carrying test vehicle is to evaluate the hovering performance, stability, and control of a vehicle using annular recirculation. Author

# 05 ASTRONOMY AND ASTROPHYSICS

Includes celestial mechanics; and radioastronomy.

*For related information see:* 12 Geophysics; and 29 Space Sciences.

**N63-13794** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**THE CHARACTERISTICS OF DISTANT COMETS**
Bertram Donn Washington, NASA, Mar. 1963 10 p 21 refs Previously processed as a preprint; for abstract see N63-13875 08-28 (NASA TN D-1671) OTS: $0.50

An analysis of spectroscopic observations and colors of comets with heliocentric distances greater than 3.5 AU indicates that only sunlight scattered from solid grains can explain the data. The orientation and curvature found by Osterbrock in two comets are consistent with Bessel-Bredichin theory of comet tails. Because of these characteristics, Brandt's use of these comet tails to study the interplanetary medium is not valid. Author

**N63-13991** Chicago U. Enrico Fermi Inst. for Nuclear Studies
**KINEMATICAL HYDROMAGNETIC THEORY AND ITS APPLICATION TO THE LOW SOLAR PHOTOSPHERE**
E. N. Parker Jan. 1963 69 p 34 refs Submitted for Publication
(NASA Grant NsG-96-60)
(EFINS-63-1) OTS: $6.60 ph, $2.27 mf

The magnetic field, B, is computed from the hydromagnetic equations for a variety of given velocity fields v. The velocity fields are classified as turbulent if their time correlation extends no more than their scale $\alpha$ divided by their characteristic velocity, v. The velocity fields are classified as persistent if their time correlation extends beyond $\alpha/v$, but is short compared to the magnetic diffusion time $\alpha^2/\lambda$ ($\lambda \equiv c^2/\Delta\pi\sigma$), and as stationary if their time correlation extends beyond $\alpha^2/\lambda$. It is shown that turbulent fluid motions in the solar photosphere generate rms fields which are a few times the large-scale field strength $B_o$ in the photosphere. Where $B_o \geq 20$ gauss, this leads to equipartition of energy between the turbulent magnetic and velocity fields. It is conjectured that, since plages occupy the areas on the solar surface where $B_o \geq 20$ gauss, there may be some connection between equipartition and plage formation. It is shown that persistent motions tend to draw the field into concentrated sheets and filaments. The observed supergranulation in the solar atmosphere tends to concentrate vertical magnetic fields around the edges of the cells where the field density may become $10^2$ times longer than in the interior of the cell. It is shown that stationary motions tend to exclude the magnetic field from the region of fluid motion. Author

**N63-14008** Arizona U. Lunar and Planetary Lab., Tucson
**COMMUNICATIONS OF THE LUNAR AND PLANETARY LABORATORY, VOLUME I, NUMBERS 14-16**
Barbara Middlehurst and Gerard P. Kuiper, eds. 1962 57 p 28 refs For Vol. I, Nos. 7-10 see N62-16618 17-28; for Vol. I, No. 11 see N62-16699 17-28; and for Vol. I, Nos. 12-13 see N62-16619 17-28
(NASA Grant NsG-161-61)
OTS: $5.60 ph, $1.91 mf

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3. AN INFRARED STELLAR SPECTROMETER G. P. Kuiper, R. Goranson, A. Binder, and H. L. Johnson p 119-127 6 refs (See N63-14011 09-15)

N63-14010 Arizona U. Lunar and Planetary Lab., Tucson

**INFRARED SPECTRA OF STARS AND PLANETS, I: PHOTOMETRY OF THE INFRARED SPECTRUM OF VENUS, 1-2.5 MICRONS**

Gerard P. Kuiper *In its* Communications of the Lunar and Planetary Laboratory, Vol. I, No. 15, Oct. 26, 1962 p 83-117 10 refs (See N63-14008 09-05)

Spectrographs of Venus for the 1.0- to 2.5-micron region are given and compared to the spectra of $CO_2$ obtained in the laboratory. The Venus observations were made with the 36-inch telescope of the Kitt Peak Observatory in June 1962 and with the 82-inch telescope of the McDonald Observatory in August 1962. R.C.M.

N63-14178 Air Force Cambridge Research Labs. Geophysics Research Directorate, Bedford, Mass.

**VISUAL HIGH RESOLUTION OBSERVATIONS OF SUNSPOTS Research Note**

Patrick S. McIntosh Sept. 1962 16 p
(AFCRL-62-890)

This report presents the results of a study to determine the value of visual observations of the fine structure and evolution of sunspots, by means of free-hand drawings of sunspot groups obtained with a 3.5-in. catadioptric Questar telescope on several consecutive days. Whereas photographs of the sunspot features are preferable to the drawings, drawings do make a contribution to the qualitative understanding of sunspots, especially when it is not possible to obtain photographs of comparable resolution. Author

N63-14186 Air Force Cambridge Research Labs. Geophysics Research Directorate, Bedford, Mass.

**SOLAR FLUX MEASUREMENTS, APRIL 1962, AND ANTENNA CONSIDERATIONS Research Note**

John P. Castelli Dec. 1962 21 p 10 refs
(AFCRL-62-1111)

For ten days in April 1962, solar-power-flux density was measured simultaneously at four frequencies using the 84-ft-diameter radio telescope at Hamilton, Mass. The frequencies were 2965 mc, 1200 mc, 400 mc, and 225 mc. In addition, data were available for several days at 94 kmc through the courtesy of C. W. Tolbert of the University of Texas. Data at 9180 mc were taken at Hamilton, Mass., with an 8-ft antenna. Apart from the solar data presented, various antenna parameters of the 84-ft parabola are reviewed and presented along with the method of determination. The method is presented by which the recorded data were corrected for these in determining true flux. Author

# 06 AUXILIARY SYSTEMS

Includes: fuel cells and solar cells; gas turbines; hydraulic, pneumatic and electrical control systems and actuators; and inverters.

*For primary propulsion systems see:* 27 Propulsion

*For related information see:* 08 Communications; 09 Electronics; 10 Facilities; 15 Instrumentation; and 22 Navigation and Guidance.

N63-13961 Electro-Optical Systems, Inc., Pasadena, Calif.

**FEASIBILITY STUDY TOWARD DEVELOPMENT OF RADIATION RESISTANT SOLAR CELL Interim Engineering Report, 1 November 1961 through 30 June 1962**

S. Kaye July 31, 1962 22 p
(NASA Contract NAS7-92)
(EOS-2080-IR-1) OTS: $2.60 ph, $0.86 mf

Progress in the development of radiation-resistant solar cells is reported. Radiation resistance has been achieved by the use of a graded base structure in which an impurity gradient is introduced into the base region of the cell. The effect of this impurity gradient is to form an electric field in the base region of the cell, which accelerates the light-produced minority carriers toward the junction. Techniques for fabricating n on p cells with this impurity gradient are described. Cells made by these techniques have shown conversion efficiencies in excess of 10% in sunlight; and their resistance to both high-energy electron and proton irradiation was found to be improved by a factor of 3 to 5 over conventional n on p solar cells. M.P.G.

N63-14123 Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J.

**PROCEEDINGS [OF THE] 16TH ANNUAL POWER SOURCES CONFERENCE, FORT MONMOUTH, N. J., MAY 22-24, 1962**

Red Bank, N.J., PSC Publications Committee [1962] 182 p 143 refs Available from PSC Publications Committee, P.O. Box 891, Red Bank, N.J.

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**N63-14124** Army Signal Research Lab., Fort Monmouth, N.J.

**ORGANIC ION-EXCHANGE MEMBRANES**

John Perry, Jr. *In* Army Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 1-3 6 refs (See N63-14123 09-06)

Investigations were conducted to improve the performance of hydrogen-oxygen, ion-exchange-membrane fuel cells. These investigations were concentrated on improving electrodes and membrane electrolyte materials. Fuel-cell performance was increased from approximately 8 $ma/cm^2$ using porous sintered nickel and porous carbon carriers to 38 $ma/cm^2$ using platinum-imprinted membranes. The increase in cell performance was due mostly to the improved contact between the membrane and electrode surface areas. The use of wicking devices, dual membrane cells, and mosaic-type membranes promises increase in fuel cell life and in the current densities obtained from the fuel cells. B.J.C.

**N63-14125** Armour Research Foundation, Chicago, Ill.

**INORGANIC ION-EXCHANGE MEMBRANES**

A. Dravnieks, D. B. Boies, and J. I. Bregman *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 4-5 6 refs (See N63-14123 09-06)

Merits of the zirconyl phosphates as ion-exchange electrolytes were explored in hydrogen-oxygen fuel cells. The ion-exchange materials were prepared by precipitation from a mixture of zirconium nitrate and phosphoric acid at a mol ratio 1:2.5. Results of the investigation showed that cells with an inorganic ion-exchange electrolyte perform at current densities approaching those of the early organic membrane cells. Furthermore, operation at temperatures of 90° to 100° C is possible with these cells as long as hydration of the solid electrolyte can be assured. B.J.C.

**N63-14126** Speer Carbon Co., Niagara Falls, N.Y.

**CARBON ELECTRODES**

W. E. Parker and R. W. Marek *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 6-8 10 refs (See N63-14123 09-06)

A program is being conducted to develop carbon and graphite materials suitable for use as electrodes in fuel cells. Electrochemical evaluation of experimental electrodes has been started. Although results to date are insufficient to be conclusive, continued study is expected to yield definite relationships between physical properties of the electrodes and their electrochemical characteristics. The availability of such data should lead directly to the fabrication of optimum carbon electrodes. B.J.C.

**N63-14127** Electric Storage Battery Co., Philadelphia, Pa.
**METALLIC ELECTRODES FOR $H_2$–$O_2$ FUEL CELLS**
J. C. Duddy, D. T. Ferrell, and P. Ruetschi *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 9-12 3 refs (See N63-14123 09-06)

Microporous metallic electrodes for alkaline hydrogen-oxygen fuel cells have been developed. Advantages of these electrodes are that they are nonpyrophosphoric and can be exposed to the atmosphere. Also, they show no "drowning" effects at continuous high currents (200 mA/cm$^2$ at a temperature of 60° C), and they exhibit excellent life characteristics. B.J.C.

**N63-14128** Army Signal Research and Development Lab., Fort Monmouth, N.J.
**$H_2$ AND $O_2$ ELECTRODES FOR ACID MEDIA**
Walter G. Taschek and James E. Wynn *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N. J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N. J., May 22-24, 1962 p 12-15 4 refs (See N63-14123 09-06)

A new method is proposed for converting the chemical energy of liquid organic fuels directly into electrical energy. The approach that is used is converting the liquid primary organic fuel to hydrogen and using the hydrogen fuel in the fuel cell. This approach necessitates the use of both hydrogen and oxygen electrodes that can tolerate fuel or electrolyte contamination with $CO_2$. For this approach, acid electrolytes are mandatory. Also, highly efficient operation of the oxygen or air electrode in these media is essential, since these electrodes determine the overall cell voltage. Thus investigations of high-drain hydrogen and oxygen electrodes in acid media were made. By means of a new preparation technique for catalyzed activated carbon electrodes, the performance of both anode and cathode was improved far above that obtained with a previous technique that involved: activitation of a porous carbon electrode in a carbon dioxide atmosphere and catalyzing with platinum, followed by wetproofing with paraffin. Over a 40-fold increase in current density is obtained with the new carbon electrode preparation technique that involved three basic steps in the following order: activitation, wetproofing, and catalyzation. A comparison of the two techniques indicates that the activitation times and temperatures, wetproofing solutions, and catalyst concentrations and application temperatures are essentially the same for both the old and the new carbon treatments. The difference between the methods lies in the sequence in which each step is placed. The old carbon treatment required wetproofing with an appropriate agent as the final step; the new method requires catalyzing the carbon carrier, previously wetproofed, as the final step. Catalyzing the carrier should be the final step because catalyst sites are exposed to the fuel or oxygen gas so reaction takes place readily. The heat effects observed, using this new technique, increase cell performance by reducing polarization effects at the electrodes at high current drains. B.J.C.

**N63-14129** Pennsylvania U., Philadelphia
**MECHANISM OF THE OXYGEN ELECTRODE**
M. A. V. Devanathan *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 15-18 17 refs (See N63-14123 09-06)

Investigations that have been conducted to facilitate understanding of the mechanism of the oxygen electrode reaction are reviewed. B.J.C.

**N63-14130** Magna Corp. Research and Development Labs., Anaheim, Calif.
**BIOCHEMICAL FUEL CELLS**
G. H. Rohrback, W. R. Scott, and J. H. Canfield *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 18-21 (See N63-14123 09-06)
(Contracts NObs-78659, NObs-84243, and NObs-84622)

The general principles and characteristics involved in biochemical fuel cells are outlined. Data are given on several different bioelectrode systems. B.J.C.

**N63-14131** General Electric Co., Lynn, Mass.
**ION EXCHANGE MEMBRANE FUEL CELLS**
E. A. Oster *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 22-24 (See N63-14123 09-06)

An ion-exchange membrane fuel cell has been developed for military and space power systems. The cell consists of a thin organic membrane with each side covered by an active porous electrode structure. The entire electrochemical cell is about one-half millimeter thick with each electrode nearly one-tenth of a millimeter deep. Suitable gas manifolding and current-collectors can be put around each thin cell in such a way that about five cells may be put in series per linear inch of battery stacks when operation with hydrogen and oxygen from convected air is desired. To achieve lower internal resistance and better chemical stability over a range of operating temperatures with this type of cell, cation-exchange membranes in their acid form are preferred to anion-exchange membranes in the hyrdoxyl forms. The cells are well leached with pure water after manufacture so that very few mobile anions are present. Thus they closely approximate the classic electrochemical (1,0) electrolyte in which the flowing hydrogen ions carry all the ionic current. B.J.C.

**N63-14132** Allis-Chalmers Mfg. Co., Milwaukee, Wis.
**THE USE OF A POROUS ELECTROLYTE VEHICLE IN FUEL CELLS**
R. A. Wynveen and T. G. Kirkland *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 24-28 (See N63-14123 09-06)

Operating principles are given for the Allis-Chalmers fuel cell which uses a porous electrolyte vehicle of asbestos to retain the fuel cell electrolyte between the electrodes. The cell uses hydrogen and oxygen as the fuels. A potassium electrolyte is held in a high-capillary-potential, electrolyte vehicle. (The capillary potential is the pressure that is required to force a gas bubble through the largest pore in the electrolyte-containing vehicle.) The oxygen and hydrogen electrodes are each contained in a nickel-plated metal electrode holder. The function of the holder is to: (1) hold the electrode in position by being recessed slightly less than the thickness of the electrode; (2) manifold the gas across the face of the electrode; (3) serve as the bipolar electrical lead; (4) act as heat transfer medium; and (5) serve as structural support for the cell. Continuous operation of the hydrogen-oxygen cell requires the removal of water produced by the cell reaction as rapidly as it is formed. The advantage obtained by employing a high capillary electrolyte holder is that, for moisture buildup or moisture depletion, the high capillary action of the electrolyte vehicle tends to distribute the electrolyte content evenly through the cell. The control of the moisture content and, therefore, control of optimum voltage under a constant load, is not critical because sudden drying or flooding is not possible.

In addition, it has been found that a pressure difference between the hydrogen and oxygen sides of 100 p.s.i.g. would be required to force gas through the asbestos-containing electrolyte. This means that there is little chance for mixing of the fuel gases, an important "built-in" safety factor. B.J.C.

**N63-14133** Esso Research and Engineering Co. Products Research Div., Linden, N.J.

**METHANOL FUEL CELLS**

Barry L. Tarmy *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 29-31 3 refs (See N63-14123 09-06)
(Contract DA-36-039-sc-89156)

Measurements have been made of the performance of methanol and oxygen electrodes in $H_2SO_4$ and $H_3PO_4$ electrolytes. These have shown that $H_2SO_4$ is a superior electrolyte because of better oxygen electrode performance. It was found that such common electrolyte contaminants as metal ions or oxygen do not hurt fuel electrode performance. Furthermore, the oxygen electrode can operate efficiently with methanol present close to concentrations at which the fuel electrode can also operate without loss of performance. These data give promise to the prospect of combining components of a soluble carbonaceous fuel-air fuel cell without severe losses in voltage due to their interactions. B.J.C.

**N63-14134** General Electric Co., Schenectady, N.Y.

**HYDROCARBON FUEL CELLS**

W. T. Grubb *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf. Fort Monmouth, N.J., May 22-24, 1962 p 31-34 5 refs (See N63-14123 09-06)
(Contract DA-44-009-eng-3771)

A pasted-catalyst screen-electrode structure has been developed which will accommodate any electrode material in powder form while achieving high triple contact zone per unit geometric area. About 450 electrode-electrolyte-fuel systems were investigated using this electrode structure, and the conclusions to date are: (1) platinum black is the best simple catalyst for the anodic oxidation of hydrocarbons near room temperature; (2) self-oxidizing, non-noble metals are unsatisfactory catalyst materials; (3) electrocatalysis is a more restrictive factor than gas phase catalysis in the choice of materials; (4) the electrolyte strongly affects the rate of electrochemical oxidation of the various gaseous hydrocarbons studied; (5) in the series of hydrocarbons based on methane and its methyl substitution products, propane displayed maximum reactivity in a platinum anode-acid electrolyte cell at 65° C, but ethylene sustained higher load currents than any of the saturated hydrocarbons. M.P.G.

**N63-14135** Westinghouse Electric Corp., East Pittsburgh, Pa.

**SOLID ELECTROLYTE FUEL CELLS**

D. H. Archer and E. F. Sverdrup *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 34-39 3 refs (See N63-14123 09-06)

Computations important to the design and operation of solid electrolyte fuel cell systems are illustrated for a hydrogen-oxygen system. The design method can be carried over to hydrocarbon-air systems. Although no attempt at system optimization has been made, power to electrolyte area ratios of 46 watts/ft$^2$ and thermal efficiencies greater than 42 percent are indicated for hydrogen-oxygen systems using a $Zr_{0.85}Ca_{0.15}O_{1.85}$ electrolyte with a thickness of 0.7 mm. B.J.C.

**N63-14136** Union Carbide Consumer Products Co. Product and Process Development Lab., Cleveland, Ohio

**RADIOACTIVE REGENERATE FUEL CELLS**

J. F. Yeager, R. J. Bennett, and D. R. Allenson *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 39-42 7 refs (See N63-14123 09-06)

A feasibility study, leading to the development of a nuclear-radiation energized electrical-power source, is being conducted. The design, development, and fabrication of an operating prototype, having 5-watts electrical output for feasibility demonstration purposes, is discussed. However, primary emphasis is placed on the electrochemistry of the specific chemical system chosen. The radiochemical, regeneration fuel-cell scheme of J. A. Ghormley is applied to the prototype. An acidified oxygen-free, ferrous sulfate solution is irradiated by a source of high-energy radiation (e.g., gamma radiation from a cobalt 60 source). The products observed in the irradiation of an aqueous solution of sulfuric acid are: 4.50 $H_2O \rightarrow 3.70\ H + 2.90\ OH + 0.40\ H_2 + 0.80\ H_2O_2$, where the number represents yields in molecules per 100 ev. The measured yield for oxidation of ferrous ion is considerably greater than can be accounted for on the basis of Oh and $H_2O_2$. This increased yield is the result of oxidation by the H atoms. In the overall process for each two ferric ions formed there is one hydrogen molecule formed. B.J.C.

**N63-14137** United Aircraft Corp., East Hartford, Conn.

**REGENERATIVE $H_2$–$O_2$ FUEL CELL SYSTEM**

A. C. Ching and F. Cohen *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 42-45 1 ref (See N63-14123 09-06)
(Contract DA-36-039-sc-85259)

An analysis was made of a 500-watt electrolytically regenerative hydrogen-oxygen fuel-cell powerplant incorporating solar cells for both primary and regenerative power. The powerplant is for earth orbiting satellites where the fuel cell provides power during the shade portion of orbit, and solar cells furnish the onboard power during the sunlight phase of orbit and also supply sufficient energy to regenerate the fuel cell reactants. The system is designed to deliver 500 watts continuously at a nominal 28 volts during all orbit conditions. The analysis represents an optimization study of the system for operation in all earth orbital altitudes from 300 to 22,400 miles. In the analysis, the principal components or subsystems were optimized individually and then integrated to achieve a composite system having minimum weight consistent with existing state-of-the-art technology in relation to construction and performance. Evaluation results showed that a regenerative, fuel-cell system is a feasible power source for an orbiting mission and requires no principal components which have not been operated to demonstrate the performance levels considered in the analysis. The system also offers a considerable potential for further performance improvement and weight reduction based on recent progress in current research programs. B.J.C.

**N63-14138** Minneapolis-Honeywell Regulator Co., Minn.

**CONTROLS FOR FUEL CELL BATTERIES**

Powell A. Joynef and Joseph O. Thorsheim *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 45-48 (See N63-14123 09-06)

A pressure controller has been developed for hydrogen-oxygen fuel batteries that can function in several optional modes; it is a modular assembly of mutually-referenced differential pressure regulators with pressure reliefs. The controller is sized for a maximum flow rate of 28 liters per minute of either reactant gas, corresponding to the capacity required by a 3-kw hydrogen-oxygen fuel battery

operating at 50 percent efficiency. It will also handle small single-cell laboratory fuel cells with equal facility. The controller is self-powered and weighs approximately 1.6 kg. It is equipped with fail-safe dual diaphragms so that the rupture of one diaphragm will shut the controller down with the second diaphragm still intact. This fail-safe feature prevents any internal mixing of reactant gases. Prototype models of the controller have been successfully tested in several leading fuel-cell laboratories and have controlled single cells, multicell modules, and multimodule batteries in the kilowatt range for thousands of hours. B.J.C.

**N63-14139** Bureau of Ships, Washington, D.C.

**250 WATT PROPANE-FIRED THERMOELECTRIC GENERATORS**

P[atrick] A. O'Riordan *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 49-51 (See N63-14123 09-06)
(Contracts NObs-78197 and NObs-78198)

Propane-fired thermoelectric generators are described and the results of performance tests are given. Two 250-watt units have been built, one by the Minnesota Mining and Manufacturing Company (3M-5B1) and the other by the Westinghouse Electric Corporation. The 3M-5B1 weighs 37.7 pounds and has a net overall efficiency of 2.4 percent while producing 260 watts at 27.1 volts d.c. The Westinghouse generator weighs 35.6 pounds and has a net overall efficiency of 1.4 percent while producing 267 watts at 20 volts d.c. This generator showed a 10% to 15% degradation in power output after 1000 hours of operation while the 3M-5B1 showed a degradation of 14% after 1600 hours. R.C.M.

**N63-14140** General Instrument Corp., Newark, N.J.

**A 45 WATT THERMOELECTRIC GENERATOR FOR FIELD USE**

Melvin Barmat *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 52-55 (See N63-14123 09-06)

A prototype thermoelectric power supply has been built that uses gasoline as a fuel. The power supply consists of a lead-telluride thermoelectric generator that uses forced convection cooling while producing a net output of 45 watts at 6 volts for 12 hours. The entire system weighs 10 pounds, including the loaded gasoline fuel. The subassemblies of the system are described and preliminary test results are discussed. R.C.M.

**N63-14141** North American Aviation, Inc., Los Angeles

**DESIGN CONSIDERATION FOR GASOLINE-POWERED THERMIONIC GENERATORS**

W. R. Martini *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 55-60 5 refs (N63-14123 09-06)
(Contract DA-36-039-sc-88982)

This paper summarizes the requirements that a portable thermionic power source must meet, outlines the engineering and design problems that these requirements raise, and presents some results of research pointing toward the solution of these problems. B.J.C.

**N63-14142** Thermo Electron Engineering Corp., Waltham, Mass.

**PROGRESS IN THE CESIUM THERMIONIC CONVERTER**

George N. Hatsopoulos, S. Kitrilakis, and Felix Lyczko *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 60-64 7 refs (See N63-14123 09-06)

Research toward the construction of a thermionic converter utilizing cesium is reviewed as follows: design of a test diode; power output; electron cooling; cesium conduction; radiation losses; diode efficiency; and the coupling of a diode with a hydrocarbon fueled heat source. R.C.M.

**N63-14143** Martin Co., Baltimore, Md.

**RADIOISOTOPE POWER SOURCES**

Wilfred L. Kershaw *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 64-67 (See N63-14123 09-06)

Five radioisotope fueled generators are described that were placed in service in remote locations in space and on earth. The successful operation of these units has opened new possible applications and has fostered the large-scale production of strontium-90, which in turn has reduced fuel costs by a factor of 10. B.J.C.

**N63-14144** North American Aviation Inc., Los Angeles, Calif.

**NUCLEAR REACTOR POWER SOURCES**

C. K. Smith *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 68-70 (See N63-14123 09-06)
(Contract AT(11-1)-GEN-8)

Compact reactor technology has been advanced during the past few years to a state where several very flexible, high-performance, reliable, and compact systems for space and terrestrial applications will become available within a relatively short time. Advanced systems to fill future needs have been envisioned and work to advance the states of applicable technologies is progressing. Author

**N63-14145** Radio Corp. of America. Semiconductor and Materials Div., Somerville, N.J.

**NEW SOLAR CELL DEVELOPMENTS, PART I**

M. F. Lamorte, G. W. McIver, and J. J. Wysocki *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 71-73 1 ref (See N63-14123 09-06)

Characteristics of gallium arsenide solar cells having efficiency values ranging from 11 to 12 percent have been reported. These devices were developmental in nature, and had junction areas of approximately 0.75 square centimeter. This paper presents data on more recent GaAs solar cells having junction areas of 2-square centimeters. The efficiency values of these cells correspond very closely to those obtained for the developmental cells. Other values obtained for these cells, such as voltage, current, power, also correspond to values obtained for the developmental cells. B.J.C.

**N63-14146** Army Signal Research and Development Lab., Fort Monmouth, N.J.

**NEW SOLAR CELL DEVELOPMENTS, PART II**

James S. Kesperis *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J. May 22-24, 1962 p 73-77 7 refs (See N63-14123 09-06)

The status of the ARPA (Advanced Research Projects Agency) sponsored, contractural program of the Signal Corps is reported for the area of new materials and techniques for photovoltaic energy conversion during 1961 and 1962. B.J.C.

**N63-14147** Goodyear Aircraft Corp., Akron, Ohio

**ORIENTATION SYSTEM FOR A SOLAR POWER SUPPLY FOR GROUND USE**

G[erald] J. McKeel *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J. May 22-24, 1962 p 77-80 5 refs (See N63-14123 09-06)
(Contract DA-36-039-sc-88913)

An orientation sensor that provides a directional error signal while in the sun's illumination is presented for automatically orienting

solar-energy conversion devices. Amplifiers are not required, and no standby power is consumed in the event of cloud cover or during the period between sunset and sunrise. The sensor is described in conjunction with an on-off drive system (single axis) to provide unattended tracking of the sun to 10 degrees or better for a 30-day period of operation. Developments are presented which indicate the feasibility of tracking the sun to an accuracy of ±1 degree with a completely automatic two-axis control system. The sensor and its associated equipment will enable the development of solar orienting systems for ground use. These systems will have minimum power drain and will be capable of providing unattended tracking for solar cell panels, thermionic converters, parabolic reflectors, and other units that convert solar energy into electrical energy. B.J.C.

**N63-14148** Spectrolab, Inc., North Hollywood, Calif.
**PHOTOVOLTAIC SYSTEM USING CONCENTRATORS**
J[ames] G. Leisenring *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 81-84 (See N63-14123 09-06)
(Contract DA-36-039-sc-87449)

System parameters affecting the selection of filter designs for use with silicon solar-cell concentrators were evaluated and the design criteria and performance for realizable filters for use with such systems were established. The results of this study showed that cells having a low series resistance and a small temperature coefficient have a higher performance when used with concentrators. Reflecting-type filters used on the concentrating surfaces should approach the ideal filter characteristics in order to maximize the power output obtained from any given type of silicon solar cell. In general, the power output of a silicon-solar-cell per unit-cell-area in space can be increased between two to three times by the proper selection of filters, concentration ratios, and heat transfer design of the solar power system. Significant advances in space vehicle and possibly in ground applications can be achieved by using photovoltaic systems utilizing concentrators. B.J.C.

**N63-14149** National Aeronautics and Space Administration, Washington, D.C.
**RADIATION-RESISTANT SOLAR CELLS. A PANEL DISCUSSION**
W. R. Cherry et al *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 85-93 (See N63-14123 09-06)

A panel discussion was held on the radiation damage to and radiation resistance of solar cells. B.J.C.

**N63-14150** Cook Electric Co., Chicago, Ill.
**EVALUATION OF BATTERIES FOR SATELLITE APPLICATIONS**
William Ingling *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J. May 22-24, 1962 p 94-96 1 ref (See N63-14123 09-06)

A study is made of the 12-ampere-hour nickel-cadmium used to obtain a highly reliable, long-life, energy conversion unit for systems operating in a space environment. The sealed nickel-cadmium cell was designed for shallow discharge in a 16°C to 32°C environment. The cycle life of the cell was considerably less in temperature environments above and below 24°C. The cycle life decreases as the depth of discharge increases, and decreases as the environmental temperature varies significantly from room temperature. The shorter cycle life of the cells when operated in a 49°C environment, as compared to a 24°C environment, is believed to be the result of a higher rate of degradation of the cellulose separator material at the higher temperature. It was found that when the cells were operated in a -18°C or -34° C environment, it was necessary to increase the charging voltage in order to obtain the proper recharge after any reasonably deep discharge for the specified time. The consistently greater cycle of the 20-cell batteries with respect to cell groups and corresponding test conditions is attributed to the difference in separator material, which is polypropylene for the batteries as opposed to cellulose for the cell groups. J.R.C.

**N63-14151** Gulton Industries, Inc., Metuchen, N.J.
**SEALED NICKEL-CADMIUM BATTERIES**
H. N. Seiger, P. B. Pinches, H. I. Cohen, and R. C. Shair *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 96-99 2 refs (See N63-14123 09-06)

Ten new separator materials used in nickel-cadmium batteries were put through screening tests developed to evaluate candidate materials. The tests consisted of: (1) determining the amount of electrolyte absorbed by a separator, and measuring the amount lost during an acceleration at 25G for 2 minutes; (2) determining the electrical resistance after wetting in electrolyte, and after storage for 30 days at -40°F and 125°F; and (3) determining mechanical strength and dimensional stability after storage in electrolyte at -40°F and 125°F. It has been found that good hermetically sealed cell operation is associated with materials that imbibe electrolyte to the extent of at least four times the dry weight. J.R.C.

**N63-14152** Sonotone Corp., Elmsford, N.Y.
**HIGH CAPACITY SEALED NICKEL-CADMIUM BATTERIES**
Francis Alliegro, Louis Belove, and Peter Voyentzie *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 99-101 (See N63-14123 09-06)

A study is made of a high-capacity, sealed, nickel-cadmium battery system, in which certain characteristics of semiconductor devices are employed to achieve maximum capacity utilization. The useful capacity of a nickel-cadmium battery in satellite application has been limited by the high-rate overcharge. The charging cycle is controlled by the use of a zener diode acting as a shunt when the battery charge voltage rises to an undesirably high level. The cells are rated individually for their capacities and the batteries are built with cells that are closely matched. This technique prevents any one cell from being driven by another cell or group of cells. J.R.C.

**N63-14153** Army Signal Research and Development Lab., Fort Monmouth, N.J.
**SEALED CADMIUM-SILVER OXIDE BATTERIES**
Arthur M. Frink, Jr. *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 102-105 (See N63-14123 09-06)

A study is made of some of the advantages of sealed cadmium-silver oxide batteries. Based on the information and data available at the present time, the capabilities of the sealed cadmium-silver system may be summarized as follows: (1) greater energy output per unit weight and volume than the nickel-cadmium system, but less than the zinc-silver oxide system; (2) good cycle life; (3) maintenance-free operation; (4) excellent ampere-hour charge efficiency; (5) good charge retention; and (6) the ability to be constructed as a non-magnetic power supply for use in applications where this property is required. J.R.C.

**N63-14154** General Motors Corp. Delco-Remy Div., Anderson, Ind.
**SEALED ZINC-SILVER OXIDE BATTERIES**
J. A. Keralla and J. J. Lander *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouthm N.J., May 22-24, 1962 p 105-107 (See N63-14123 09-06)
(Contract AF 33(600)-41600)

The cell development and test phrase of a program directed at obtaining a hermetically sealed zinc-silver oxide secondary battery for aerospace application are discussed. A battery was designed to deliver 5000 continuous cycles while operating in the voltage range of 27.5±1.5, at temperatures from 0° F to 100° F in a vacuum of $10^{-9}$ mm mercury in a zero-gravity environment. A cycle is defined as a 35-minute discharge at 20 amperes, followed by 85 minutes of charge. The following factors in cell design resulted in increased cycle life: thin plate construction; the use of polyvinyl alcohol as a binding agent in the negative active material; increased separator thickness; and the use of a thin, porous, inert layer of material next to the positive plate. At 30° F, the cells did not cycle extensively at 21% depth-of-discharge, or more, due to inability to accept charge in the allotted 85 minutes. At room temperature and 100° F, cycle life depended markedly on depth-of-discharge. It is anticipated that loss of negative material will cause failure where sufficient separation is provided. Based on this work, energy deliveries of zinc-silver oxide batteries are expected to be 5 watt to 8 watt hours per pound for the two-hour cycle, at room temperature, with life in excess of 1000 cycles. Greater depths of discharge can provide higher energy yields at the cost of cycle life. It is indicated that batteries can be built to satisfy minimum environmental requirements at the severity levels tested. I.v.L.

**N63-14155** Defence Research Chemical Labs., Ottawa (Canada)
**CANADIAN RESEARCH ON SECONDARY BATTERIES**
T. E. King, E. J. Casey, and H. S. Henderson *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 108-112 18 refs (See N63-14123 09-06)

A review is presented of lead acid, nickel-cadmium, and zinc-silver oxide secondary batteries in the light of operation, maintenance, or design. I.v.L.

**N63-14156** Radio Corp. of America. Semiconductor and Materials Div., Somerville, N.J.
**NEW SECONDARY ELECTROCHEMICAL SYSTEMS**
G. S. Lozier and E. F. Uhler *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 112-116 10 refs (See N63-14123 09-06)

Experimental studies of molten-salt systems were conducted to determine the reversibility of various anode-cathode couples under charge and discharge conditions. Combinations of known reversible anode and cathode materials, separated by ceramic separators, were used. The following coupling systems were investigated: molten-chloride electrolyte; molten-sulfate electrolyte on the cathode side; and molten-fluoride electrolyte on the anode side. Results indicated the feasibility of reversible electromechanical couples using high-capacity reactant materials and a molten salt electrolyte. I.v.L.

**N63-14157** Ford Motor Co., Dearborn, Mich.
**A TEST-TO-FAILURE PROGRAM FOR THERMAL BATTERIES**
H. J. Langlie *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 117-120 3 refs (See N63-14123 09-06)

A testing method for obtaining "test-to-failure" data on thermal batteries and other one-shot items included in the Shillelagh missile system is discussed. This test method involves selecting stress levels for the test factor, e.g., vibration level, temperature, drop height, etc., as the test progresses, in such a manner as to make use of the immediately preceding test results. The test begins by constructing an interval sufficiently large to include all of the inherent strengths of the test specimens with regard to the test factor. This is called the test interval. For example, a range of 100° F to 300° F might well be chosen for a battery designed to operate up to 180° F. The first stress level is selected at the midpoint of the interval, e.g., 200° F. After the battery has been properly soaked, it is activated and the results are analyzed to determine success or failure. In the case of success, the next stress level is selected at halfway between the preceding test level and the upper limit of the interval. In the case of failure, the preceding test level is averaged with the lower limit of the interval. Once the test is complete, the data are analyzed using maximum likelihood equations to obtain statistical estimates of the mean and standard deviations of the population of strengths. I.v.L.

**N63-14158** Universal Match Corp., St. Louis, Mo.
**GAS GENERATORS FOR AUTOMATICALLY ACTIVATED BATTERIES**
B. E. Stauder *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 120-123 (See N63-14123 09-06)

Gas generators for automatically activated batteries are reviewed. A new propellant was developed consisting of nitroglycerine as the fuel, polybutadiene acrylic acid (C-rubber) as the fuel binder, ammonium perchlorate as the oxidizer, guanidine picrate as the coolant, and carbon black as the stabilizer. Metals were eliminated in this development in order to minimize slag production. A sealed match is described wherein the match flame is directed toward the main propellant charge. This is due to the stainless steel housing and the coined end closure. The match mix, which consists of a combination of zirconium barium chromate and ground glass, yields very little gas but delivers a copious quantity of hot sparks and has a long flame duration. A test fixture is described which incorporates the burst diaphragms found in the BA-472 and BA-485 type batteries. I.v.L.

**N63-14159** Catalyst Research Corp., Baltimore, Md.
**CHEMICALLY-HEATED AUTOMATICALLY ACTIVATED BATTERIES**
Joseph J. Holechek *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 123-126 1 ref (See N63-14123 09-06)

Automatically activated zinc-silver oxide batteries incorporating chemical heating devices were investigated. Results indicate that chemical heat may be utilized by means of a heat exchanger to promote rapid activation, normal voltage, and operating life in an automatically activated zinc-silver oxide battery over the temperature range from -65° F to 165° F. I.v.L.

**N63-14160** Eagle-Picher Co., Cincinnati, Ohio
**ZINC-SILVER OXIDE BATTERIES FOR SPACE APPLICATIONS**
E. M. Morse and D. L. Lawson *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 127-130 (See N63-14123 09-06)

The advantages of zinc-silver oxide batteries for short term (about 30 days) space applications are discussed. The zinc-silver oxide system as compared to other primary battery systems, such as the Le Clanche (manganese dioxide zinc system) and the RM cell (mercuric oxide-zinc system) provide the highest energy output per unit weight and volume. Also, the zinc-silver oxide batteries are desirable for space applications because of their widely varying discharge rates. For example, a battery may be required to start a motor requiring two hundred amperes, then later supply to a transistor circuit requiring 0.5 ampere. A zinc-silver oxide battery can meet these requirements within a ±10% voltage regulation. These batteries have been fulfilling and probably will continue to fulfill a large role as a basic power supply for orbiting military satellites that have relative short missions. However, rechargeable systems will probably take their place for larger launch vehicle requirements, and when longer-life space-vehicles become an actuality. B.J.C.

**N63-14161** Electric Storage Battery Co., Philadelphia, Pa.

**ZINC-SILVER OXIDE NON-RESERVE BATTERY**

G. M. Wylie *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 130-133 (See N63-14123 09-06)

A study is made of the zinc-silver oxide nonreserve battery having a flat plate cell and a capacity of 15 to 20 ampere-hours. An analysis showed that highly efficient, thick electrodes would be necessary to meet the energy density requirements of 75 WH/LB. Positive and negative electrodes were evaluated by being incorporated into cells and discharged at approximately an 8-hour rate. Positive electrodes were developed with theoretical efficiencies of approximately 80 percent and negative electrodes with theoretical efficiencies of approximately 75 percent. J.R.C.

**N63-14162** Radio Corp. of America, New York, N.Y.

**MAGNESIUM PRIMARY CELLS**

G. S. Lozier and R. J. Ryan *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 134-138 3 refs (See N63-14123 09-06)

(Research sponsored by ASRDL)

The effects of current density, type of alloy used as the electrolyte, and temperature on the performance of primary cells that use magnesium as an anode are investigated. The alloys investigated included those generally considered for dry cell applications: magnesium perchlorate and magnesium bromide. Anode efficiency was shown to decrease at low current densities, high temperatures, and on intermittent discharges. Considerable heat per unit of electrical energy is evolved in magnesium cells because of irreversibility and corrosion of the magnesium anode. This heat can be utilized at low temperatures to give improved performance. Use of magnesium perchlorate electrolyte had the best influence on magnesium cell performance, particularly in conjunction with a cathode of mercuric oxide, cupric oxide, manganese dioxide, or *m*-dinitrobenzene. B.J.C.

**N63-14163** Army Signal Research and Development Lab., Fort Monmouth, N.J.

**LOW TEMPERATURE PRIMARY BATTERIES**

E. J. Settembre and D. B. Wood *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 138-141 (See N63-14123 09-06)

A study is made of low-temperature primary batteries that will provide primary power under arctic conditions. Areas that have been investigated, in an effort to obtain significant improvements in the performance of batteries used under arctic conditions, are: (1) studies of Leclanche-type cell components; (2) redesign of cell structures to increase active surface area of electrodes; (3) methods of heating batteries; and (4) new electrochemical systems. J.R.C.

**N63-14164** Eagle-Picher Co., Cincinnati, Ohio

**LIQUID $NH_3$ BATTERY SYSTEMS**

D. J. Doan and L. R. Wood *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 141-144 3 refs (See N63-14123 09-06)

Developments in the design and construction of liquid ammonia electrolyte battery systems are presented. A consistent automatic activation unit has been designed to expell the electrolyte suddenly from the reservoir into the cell block; this system operates acceptably both at low and at elevated temperatures. The present cell and block construction is described. Cell modifications to improve the activation time of the cold battery are being investigated. Methods of increasing the active material concentration in the present cell volume are also being sought. The results of polarization studies indicate that a diffusion-type polarization existing at the positive electrode is the factor limiting the capacity of this system. M.P.G.

**N63-14165** Army Signal Research and Development Lab., Fort Monmouth, N.J.

**STATUS REPORT ON ELECTRICAL CONVERSION DEVICES**

Hugh J. Byrnes *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 145-147 8 refs (See N63-14123 09-06)

The present status of electrical conversion devices is seen to be a consistent trend toward miniaturization and the replacement of electromechanical devices with static electrical devices. Miniaturization is being accomplished by: (1) the use of more efficient switching components, (2) the use of a high-frequency intermediate power-mode to reduce the size of inductive and capacitive components, and (3) the application of new concepts for protecting solid-state switching elements against overloads. The development of the silicon-controlled rectifier and of circuitry using this device has made possible conversion systems with a power range of many kilowatts, thus eliminating the need for electromechanical devices. M.P.G.

**N63-14166** General Electric Co., Schenectady, N.Y.

**SWITCH MODULATION TECHNIQUES IN AC TO DC POWER SUPPLIES**

Francis C. Schwarz *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 148-150 (See N63-14123 09-06)

Techniques for increasing the efficiency and minimizing the weight of a.c. to d.c. power converters are reviewed. The inversion process, accompanied by filtering techniques, has been applied to the regulation of output voltage by phase or pulse duration modulation (PDM) methods. However, the inertia of motion of charges per unit of time poses considerable problems when moving through storage and dissipative elements of a PDM amplifier. A Frequency Modulated Self Stabilizing (FM-SS) Power Modulator is described which operates on the principle of successive voltage waveshaping, is short-circuit proof, and requires no turn-off current. This inverter was operated at a 260-watt level from a 100-volt d.c. source at 4 kc with an efficiency in excess of 90%. M.P.G.

**N63-14167** Temco Electronics, Dallas, Tex.

**ACTIVATED COMMUTATION FOR SCR POWER INVERTERS**

G. P. Underbrink *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 150-154 6 refs (See N63-14123 09-06)

Active commutation methods to improve the reliability, weight, and efficiency of the silicon-controlled rectifier (SCR) are investigated. The circuit configurations for proposed commutation methods presented for medium and high-power systems include: (1) shunt commutator with zener blocking; (2) shunt commutator with SCR steering; (3) series transformer commutator; and (4) a method using taps on the power transformer. The selection of a given technique will depend upon the objectives of a particular application, and on the transistor, transformer, and load requirements. Four general starting circuits are considered for programed starting of the SCR inverter to prevent premature core saturation; and RFI filtering techniques which will not cause operational commutation difficulties are described. M.P.G.

**N63-14168** Hamilton Standard Div., United Aircraft Corp., Windsor Locks, Conn.

**STATIC INVERTERS USING SCR WITH PULSEWIDTH CONTROL**

F. Lawn *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 154-156 1 ref (See N63-14123 09-06)

The reliability of the three-SCR regulated static inverter in both parallel and series combinations is investigated. This static inverter is the result of applying silicon controlled rectifiers (SCR) to the circuit of the controlled firing time thyratron inverter. Pulse-width control is provided by controlling the time or phase of firing of the third SCR. The system is regulated by developing a firing pulse whose phase is a function of the output voltage. In a 2-kw single-phase unit operating from a 28-v input, 50-amp SCR's, used in parallel, obtained the same required current rating as a 5-kw three-phase inverter using three 16-amp SCR's in series. Harmonic distortion was below 3%. M.P.G.

**N63-14169** Electrosolids Corp., Sylmar, Calif.

**PHASE CONTROL OF POLYPHASE STATIC INVERTERS**

Bruce Wilkinson *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 156-159 (See N63-14123 09-06)

Methods for maintaining a fixed phase relationship between the output voltages of static inverters used to produce polyphase a.c. power are investigated and compared to ideal phase control. The ideal phase control must maintain the desired phase angle under any conceivable load within the power ratings of the inverter. The basic differences between locked oscillators and phase shifters as polyphase signal generators are discussed, and phase locking schemes developed for each system are described. These schemes include the Scott "T" configuration and the three-channel configuration; the relative advantages of applying these configurations in a.c. locking, d.c. locking, and phase shifting systems are discussed. M.P.G.

**N63-14170** Minneapolis-Honeywell Regulator Co., Minn.

**OVERLOAD PROTECTION IN SOLID STATE POWER SUPPLIES**

J. L. Jensen *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 159-162 3 refs (See N63-14123 09-06)

The problems of specifying and providing overload protection for solid-state power supplies, particularly for military applications, are assessed. The general function of overload protection included (1) protection of the power supply from damage due to any type of overload, (2) minimization of disturbance to the power source, and (3) minimization of disturbance to the connected loads. Therefore, overload protection should be specified from a complete system standpoint. Recommended practices to be followed in specifying solid-state power supply requirements include (1) specifying only those load currents which will actually be encountered in use of the power supply at normal voltage operation; (2) eliminating the short-circuit current capacity requirement, except for specifying that the power supply be self-protecting under short-circuited conditions; and (3) limiting the requirements for operation under motor starting loads to those actually present in the system. M.P.G.

**N63-14171** Hoover Co. Electronics Div., Baltimore, Md.

**LOW VOLTAGE D.C. TO D.C. CONVERSION**

B. J. Dreisbach *In* Army Signal Research and Development Lab. Electronic Components Dept., Fort Monmouth, N.J. Proceedings [of the] 16th Annual Power Sources Conf., Fort Monmouth, N.J., May 22-24, 1962 p 162-165 (See N63-14123 09-06)

Since the output voltage of many solid-state power supplies is a low d.c. voltage, a need has been created for converters to step up this low source voltage. The conventional method of low voltage d.c. to d.c. conversion is to modulate the source voltage with a semiconductor switch, step-up the modulated voltage with a transformer, rectify the output of the transformer with a semiconductor device, and filter the rectified output as necessary. Specifications for converter components depend upon the power supply design and the characteristics of the equipment to be operated at the higher voltages. Thus, converter design represents a series of compromises; therefore, the manufacturer should be fully informed of the system requirements in order to present an optimum design at minimum cost. M.P.G.

# 07 CHEMISTRY

Includes: chemical analysis and identification (e.g., spectroscopy); chemical engineering; chemical properties of materials; and synthesis.

*For related information see:* 18 Materials, Metallic; 19 Materials, Non-metallic; and 26 Propellants and Combustion.

**N63-13917** Humble Oil and Refining Co., Baytown, Tex.

**A MASS SPECTROMETRIC STUDY OF HOMONUCLEAR AND HETERONUCLEAR RARE GAS MOLECULE IONS**

M. S. B. Munson, J. L. Franklin, and F. H. Field Charlottesville, Va. U. School of Engineering and Applied Science, Feb. 1963 31 p refs Submitted for Publication

(Contract Nonr-3623(00); Proj. Squid)

(HUM-1-P)

The homonuclear and heteronuclear diatomic ions of all the rare gases except radon have been studied by mass spectrometry. Appearance potentials of all except the $HeXe^+$ have been measured at pressures where three-body processes could be neglected. All are found to result from chemi-ionization reactions. Most of the heteronuclear ions have appearance potentials in the ionization continuum of the partner of lower ionization potential. Thus most of the heteronuclear ions exist at energies above one of their dissociation asymptotes, and presumably this is possible because of the noncrossing of potential energy curves. The appearance potential of $HeAr^+$, 17.9 ev, and $NeXe^+$, 16.0 ev, occurs below the lowest excited state of He and Ne, respectively, and can only be understood as resulting from reaction of a long-lived discrete excited state of argon or xenon existing in their respective ionization continua. Author

**N63-13918** Illinois U., Urbana

**A STUDY OF CONCENTRATION AND MASS FLOW DISTRIBUTIONS IN A GAS-SOLID SUSPENSION**

S. L. Soo, G. J. Trezek, R. C. Dimick, and G. F. Hohnstreiter Charlottesville, Va. U. School of Engineering and Applied Science, Mar. 1963 53 p 24 refs For Presentation at Industrial and Engineering Chem. Div. of the Am. Chem. Soc., Sept. 8-13, 1963

(Contract Nonr-3623(00); Proj. Squid)

(Tech. Rept. ILL-9-P)

Distributions of concentration, mass flow, and velocity of solid particles were studied with a fiber-optic probe and an electrostatic probe. Concepts concerning these distributions and electrostatic charges on solid particles (glass and magnesia particles in brass pipe) were advanced and substantiated. The relation between electrostatic charge on solid particles and diffusivity of solid particles, and the difference between static loading and mass-flow ratio of phases were presented and proved. Author

N63-13919 Pennsylvania State U. College of Mineral Industries, University Park

**APPROACH TO THE STEADY STATE IN COMPETITIVE-CONSECUTIVE GAS REACTIONS**

Howard B. Palmer Charlottesville, Va. School of Engineering and Applied Science, Feb. 1963 17 p 12 refs Submitted for Publication
(Contract Nonr-1858(25); Proj Squid)
(Tech. Rept. PSU-10-P)

Competitive-consecutive reaction pairs represented by $A \xrightarrow{k_1} B + C$, $A + B \xrightarrow{k_2} C + D$, do not reach a steady state. Nevertheless, experimentalists frequently assume that the rate of disappearance of A is given by $-dA/dt = 2k_1A$. This assumption is examined, and a simple criterion is developed which allows quick estimation of the time required to approach the steady state closely. The criterion defines what may be termed the pseudosteady state for the system. Its properties can be readily calculated. Four experimental examples are examined. Author

N63-13930 Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

**REACTION OF O($^1D$) WITH NITROGEN**

W. De More and O. F. Raper Nov. 1962 Rep. from J. Chem. Phys., v. 37, no. 9, Nov. 1, 1962 p 2048-2052 18 refs
(NASA Contract NAS7-100)
(JPL-TR-32-288)

Dilute solutions of $O_3$ in liquid $N_2$ have been photolyzed at several wavelengths in the ultraviolet with light from a monochromator. Nitrous oxide is formed in low quantum yield by reaction of $O(^1D)$ with the $N_2$ solvent. Addition of an inert diluent, argon, does not lower the quantum yield, showing that the reaction is not due to "hot atoms" and probably has zero activation energy. The effect added $O_2$ on the $N_2O$ quantum yield shows that $O_2$ reacts with $O(^1D)$ 4.5 times faster than does $N_2$. The wavelength dependence of the $N_2O$ quantum yield suggests that the $O(^1D)$ quantum yield in the primary step of $O_3$ photolysis is constant below about 3000 Å, but has a lower and apparently decreasing value about 3000 Å. In addition, exchange experiments with $O_2^{36}$ show that the $O(^1D)$ yield is approximately unity at 3000 Å. The principal reaction of $O(^1D)$ with $N_2$ is $O(^1D) + N_2 + M \rightarrow N_2 + O(^3P) + M$, and not $O(^1D) + N_2 + M \rightarrow N_2O + M$. The low efficiency of $N_2O$ formation is due to a feature of the $N_2O$ potential energy surfaces, which allows decomposition of the excited association complex to $N_2 + O(^3P)$, in the course of stepwise vibrational deactivation. Author

N63-13982 Reaction Motors Div., Thiokol Chemical Corp., Denville, N.J.

**INORGANIC CHEMISTRY OF THE OXYGEN SUBFLUORIDES Third Quarterly Progress Report, October 16, 1962-January 15, 1963**

A. R. Young, T. Hirata, S. Morrow, and D. Yee Feb. 15, 1963 24 p 7 refs
(Contract Nonr-3824(00); ARPA Order 314-62)
(RMD-5009-Q3)

Interesting results were obtained from studies of the reactions of dioxygen difluoride with fluorides of pentavalent Group V elements. A general reaction has been discovered which leads to the formation of white solids having oxidizing properties (see equation).

$$O_2F_2 + MF_5 \rightarrow O_2^+MF_6^- + \tfrac{1}{2} F_2$$

where: M = P, As, Sb

The characterization of these solids is incomplete, but all present evidence points to their formulation as dioxygenyl salts, $O_2^+MF_6^-$. The compounds derived from arsenic pentafluoride and antimony pentafluoride are sufficiently stable at room temperature to permit X-ray and infrared analysis. Results of initial quantitative studies of the $Cl_2$–$O_2F_2$ reaction support the hypothesis that Cl-O bonding exists in the adduct. The analytical scheme will be more complicated than had been anticipated, because the condensable portion of the decomposition products contains $ClO_2$, $ClO_2F$, and $ClO_3F$, as well as $Cl_2$. Author

N63-14045 Bureau of Mines, Washington, D.C.

**DESIGN AND CONSTRUCTION OF A LABORATORY-SCALE FLUIDIZED-BED REACTOR**

B. K. Shibler and D. A. Martin 1963 19 p 5 refs
(BM-RI-6209)

A highly flexible laboratory-scale fluidized-bed reactor was designed, constructed, and successfully operated continuously at temperatures up to 1,300° C during an investigation of thermal methods for decomposing gypsum. This report discusses briefly the many problems encountered in developing the 10-inch-diameter reactor and describes its design and construction in sufficient detail to enable other research organizations to build a comparable unit. Author

N63-14065 Wisconsin U. Theoretical Chemistry Inst., Madison

**TRUNCATED REACTION OPERATORS AND THE HELIUM PROBLEM**

William J. Meath, Kenneth M. Sando, S. Osvaldo Goscinski, and Joseph O. Hirschfelder Feb. 25, 1963 25 p 16 refs Submitted for Publication
(NASA Grant NsG-275-62(4180); Contracts AF 33(657)-7311 and NOrd-15884)
(WIS-TCI-10, Ser. 3) OTS: $2.60 ph, $0.95 mf

The truncated reaction operator is used to obtain approximate solutions to the helium problem. Basis sets comprised of configurational interaction wave functions, which have been constructed from products of uniformly scaled hydrogenic 1s and 2s functions, are used. Approximate energies, wave functions, and reaction-operator matrix elements for the $(1s)^2$, (1s) (2s) and $(2s)^2$ $^1S$ states are tabulated. The convergence of the method is discussed for specific examples, with the aid of the Feenberg perturbation series. Author

N63-14073 Lockheed Missiles and Space Co., Sunnyvale, Calif.

**NITRYL CHLORIDE ($NO_2Cl$): AN ANNOTATED BIBLIOGRAPHY**

Helen M. Abbott Jan. 1963 23 p 58 refs
(Special Bibliography SB-62-63)

This compilation consists of 58 annotated references on the compound nitryl chloride ($NO_2Cl$). Government and world literature, covering the period of 1930 through November 1962, was surveyed for information concerning the preparation, purification, explosive properties, chemical reactions, physical constants, and possible use in propellants and binders. Author

N63-14074 Radio Corp. of America. Semiconductor and Materials Div., Somerville, N.J.

**GALLIUM ARSENIDE EPITAXIAL FILM GROWTH Interim Technical Documentary Progress Report No. 1, Sept, 15—Dec. 15, 1962**

N. Goldsmith Jan. 1963 30 p 6 refs
(Contract AF 33(657)-9179)
(ASD-TR-7-995 (I))

Gallium trichloride in hydrogen is reacted with gallium metal and the products of this reaction combine with arsenic vapor to form gallium arsenide which is then deposited epitaxially on gallium arsenide substrates. An analysis of the equilibrium constant for the gallium-gallium trichloride reaction in terms of the experimental conditions leads to the conclusion that the leak rate into the system must be below $1 \times 10^{-4}$ standard cc. per second. A theory for the nonequivalence of growth rates on the (111) and ($\bar{1}\bar{1}\bar{1}$) plane is presented. Experimentally, reproducible growth rates have been achieved, substrate preparation has been standardized, and the effect of arsenic pressure on the net carrier concentration of the layer demonstrated. Preliminary evaluation of HCl as replacement for gallium trichloride indicates that it is equivalent, and a separate system using HCl as the transport agent has been constructed. Author

**N63-14090** Max-Planck-Institut für Chemie, Mainz (W. Germany)
**TRITIUM DETERMINATIONS IN ATMOSPHERIC GASES AND METEORITES Summary Report No. 2 for the Period November 1, 1961-October 31, 1962**
F. Begemann [1962] 13 p 7 refs
(Contract AF 61(052)-465)
(AFCRL-63-260)

The tritium content in atmospheric hydrogen has been determined for samples collected at ground level at Oberhausen, Germany, between September 19, 1961, and February 2, 1962. The concentration increased during this period from 3.19 to 7.04 T/H × $10^{13}$. Tests are underway to determine the tritium content of atmospheric methane. R.C.M.

**N63-14112** Mitsubishi Electric Mfg. Co., Ltd. Research Lab., Amagasaki (Japan)
**THE INFRARED ABSORPTION SPECTRA OF METHYLISOCYANATOSILANES**
Hisashi Manami and Shunichiro Nishizaki *In its* Mitsubishi Denki Laboratory Report, Vol. 4, No. 1 Jan. 1963 p 139-142 7 refs
(See N63-14104 09-01)

Infrared absorption spectra of methylisocyanatosilanes:

$(CH_3)_3SiNCO$, $(CH_3)_2Si(NCO)_2$, $(OCN)|(CH_3)_2SiO|Si(CH_3)_2(NCO)$,

$(OCN)|(CH_3)_2SiO|_2Si(CH_3)_2(NCO)$, and

$(OCN)|(CH_3)_2SiO|_3Si(CH_3)_2(NCO)$

were measured. It was shown that the characteristic absorption bands at 2,994 ~ 3,003, 2,933 ~ 2,941, 1,414 ~ 1,418, and 1,261 ~ 1,266 $cm^{-1}$ may be assigned to $CH_3(Si)$ vibration, while extremely strong absorption bands at 2,381 $cm^{-1}$ and 1,972 ~ 2,000 $cm^{-1}$ seem to be due to OCN(Si) vibration. Author

**N63-14172** Cornell Aeronautical Lab., Inc., Buffalo, N.Y.
**CHEMICAL RELAXATION WITH PREFERENTIAL DISSOCIATION FROM EXCITED VIBRATIONAL LEVELS**
Paul V. Marrone and Charles E. Treanor Feb. 1963 29 p 25 refs
(Contract DA-30-069-ORD-3443; ARPA Order 253-62; Proj. Defender)
(CAL-QM-1626-A-10)

The rate of molecular dissociation behind strong shock waves is calculated with the assumption that dissociation can occur preferentially from the higher vibrational levels. An exponential probability of dissociation from the various vibrational levels is employed using an anharmonic oscillator model. Results for the dissociation of oxygen in an argon diluent are presented. Vibrational nonequilibrium introduces a $T^{-3}$ temperature dependence into the oxygen dissociation rate constant in the range 4000° to 8000° K. A dissociation lag-time of the order of the extrapolated vibrational relaxation time is predicted immediately behind the shock front. The computed results are shown to be in agreement with available experimental results. Author

**N63-14224** National Bureau of Standards, Washington, D.C.
**VACUUM ULTRAVIOLET ABSORPTION SPECTRA OF OXYGEN IN LIQUID AND CRYSTALLINE ARGON AND NITROGEN Technical Report**
Arnold M. Bass Mar. 20, 1963 21 p 9 refs Submitted for Publication For Presentation at the Sixth Intern. Symp. on Free Radicals, Cambridge, England, July 1963
(NASA Order R-64)
(NBS-7829) OTS: $2.60 ph, $0.83 mf

The ultraviolet absorption spectra of oxygen have been observed in liquid and solid media at low temperature. By freezing slowly from the liquid phase, samples of crystalline argon and nitrogen were prepared with added amounts of oxygen ranging between 0.01% and 10%. The spectra were recorded photoelectrically, through fused silica windows, over the wavelength range from 1600 A to 3100 A. The Schumann-Runge bands of oxygen were observed in solid and liquid mixtures of oxygen in argon or nitrogen at concentrations less than 5%, over the temperature range 60° to 90° K. The bands are broad, with half-intensity width of 150 to 550 $cm^{-1}$, and show no structure. The bands show a slight shading toward the violet in contrast to the bands in the gas phase, which are displaced toward lower frequencies by 50 to 400 $cm^{-1}$ as compared with the positions in the gas phase. These shifts appear to be slightly dependent upon temperature. The changes in position or shape of the bands between liquid and solid or between argon and nitrogen media are remarkably small. At concentration of oxygen above 5%, the Herzberg bands of oxygen were observed in the region 2400 A to 3000 A. These bands are also broad (200 to 600 $cm^{-1}$) and show some partially resolved structure. No differences were observed for changes either in temperature or matrix material. Author

**N63-14229** Air Force Office of Scientific Research, Washington, D.C.
**CHEMISTRY PROGRAM REVIEW, FISCAL YEAR 1962**
Alfred Weissler, William H. Wyatt, and Orville Rollins, eds., and Amos G. Horney Dec. 15, 1962 296 p

The chemistry program is reviewed as follows: aerospace chemistry, new methods and techniques, inorganic chemistry, chemical reactivity and mechanisms, theoretical chemistry, symposia, and chemistry program statistics. R.C.M.

# 08 COMMUNICATIONS

Includes: communications equipment and techniques; noise; radio and communications blackout; telemetry; tracking; and wave propagation.

*For tracking stations see:* 10 Facilities.

*For related information see:* 06 Auxiliary Systems; 09 Electronics; 15 Instrumentation; and 22 Navigation and Guidance.

**N63-13797** Rome Air Development Center. Techniques Lab., Griffiss AFB, N.Y.
**PREPARATION OF A RADAR CLUTTER MAP**
Norman Rosenblum Mar. 1963 14 p
(RAL-TM-63-4)

A radar clutter map for plotting the relative signal strength of ground return received from a radar as a function of range and azimuth is discussed. Measurement techniques are given for determining clutter levels, recording data, and preparing the clutter map from gathered data. A.R.B.

**N63-13807** European Atomic Energy Community, Brussels (Belgium)
**UN NUOVO CODIFICATORE [A NEW ENCODER]**
A. Alberigi-Quaranta and B. Righini (Bologna U.) [Feb.] 1963 13 p 5 refs In Italian; English summary Presented at the VII Esposizione dell'Automazione e della Strumentazione, Milan, 22-27 Oct. 1962
(Contract EURATOM 001-60-12 MPAI)
(EUR-184.i) Available from Belgian American Bank and Trust Co., N.Y., account no. 121.86: 40 Belg. Fr.

A new type of fast amplitude—number encoder is described. The circuit is based upon a closed loop formed by a delay line, an amplifier which compensates for the amplitude losses suffered by the pulses in the delay line and by a biased diode. The pulse circulation time in the circuit is 75 ns. Author

**N63-13852** Air Force Cambridge Research Labs. Electronics Research Directorate, Bedford, Mass.

**OPTIMIZATION OF ANTENNA SYSTEMS Research Report**

Allan C. Schell Sept. 1962 20 p 10 refs
(AFCRL-62-736)

A theory for assessing errors in antenna systems and determining the optimum aperture distribution for an intended use is developed. A general error criterion is formulated, and the application of the calculus of variation and constraints intrinsic to antennas results in an integral equation that defines the conditions for the optimum antenna. The theory applies directly to power-pattern synthesis, yielding aperture distributions without *a priori* specification of the farfield phase. A technique for the construction of very-large-aperture antennas is developed. This is the multiplate antenna technique, a method of aperture subdivision that provides flexible antenna performance with economy of cost. The optimization theory and the multiplate antenna technique together provide a means for achieving antennas of large size and high performance that are requisite to significant advances on a wide front of current scientific and military programs. Author

**N63-13858** Lincoln Lab., Mass. Inst. of Tech., Lexington

**SOME ASPECTS OF SPACE COMMUNICATION Final Report**

D. G. Brennan, ed., J. C. James, Joel Max, and T. F. Rogers Mar. 21, 1962 53 p 19 refs
(NASA Contract NASw-161)
OTS: $5.60 ph, $1.79 mf

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**N63-13928** Polytechnic Inst. of Brooklyn. Microwave Research Inst., N.Y.

**MEASUREMENT OF IONOSPHERIC PATHS AS A TIME-VARYING NETWORK Scientific Report No. 2**

Arthur E. Laemmel Dec. 13, 1962 13 p 3 refs
(Contract AF 19(628)-375)
(PIBMRI-1102-62; AFCRL-63-14)

The basic equations relating the input and output signals of a linear time-varying network are reviewed and put in a form convenient for multipath ionospheric radio transmission. The theory indicates that it is possible to derive enough information from an FSK (frequency shift keying) for the principal paths. Thus, the cross correlation function between the fading curves of the mark and space signals can give the mode separation data usually obtained from a special pulsed transmitter. Author

**N63-13988** Technical Research Group, Syosset, N. Y.

**THE WIDE FLAREHORN—A NOVEL FEED FOR LOW NOISE BROADBAND AND HIGH APERTURE EFFICIENCY ANTENNAS Scientific Report No. 2**

Alan F. Kay Oct. 2, 1962 85 p 6 refs
(Contract AF 19(604)-8057)
(AFCRL-62-757)

A novel feed for aperture antennas in excess of about 50λ diameter is described which has low noise, broadband, and high aperture efficiency capabilities. The theory of these feeds is described, and a comparison is made of measured and theoretical primary and secondary patterns of several feeds. Author

**N63-13989** Air Force Cambridge Research Labs., Electronics Research Directorate, Bedford, Mass.

**BROADSIDE AND SCANNED BEAMS FROM ARRAYS OF VARIABLE SPACED ELEMENTS PROXIMITY COUPLED TO A TWO-WIRE LINE Research Note**

G. R. Forbes, C. J. Sletten, and J. L. Poirier Sept. 1962 26 p 2 refs
(AFCRL-62-727)

Scanning ±50° from broadside, a new type of "stretch" antenna array consists of dipole elements proximity-coupled to an open two-wire line. The dipoles are supported at a fixed height above the transmission line and the spacing changed from λ/2 to λ. Author

**N63-14005** SHAPE Air Defense Technical Center, The Hague (Netherlands)

**THE FINE STRUCTURE OF METEOR-BURST SIGNALS**

P. J. Bartholomé Apr. 1962 48 p 8 refs
(TM-36)

The fine structure of meteor-burst signals has been studied using magnetic-tape recordings made at high speed. The experimental results can be summarized as follows: (1) Most reflections from meteor trails have a sawtooth shape, but the main contribution to the duty cycle (proportion of time available for communication) is made by signal bursts of irregular shape. (2) The rate of decay at the end of the bursts is found to range between one and several hundred decibels per second. (3) The principles of operation in communication systems of the Janet-B type, particularly the gating principle, are not well matched to the characteristics of the medium. (4) A pronounced space-diversity effect is present on longer reflections when the signal received fluctuates as a result of trail deformation. The two main conclusions are the following: (a) The performance of the Janet-B system cannot be considered as fully representative of the capabilities of the meteor-burst mode of communication. (b) A substantially improved performance, which would be much closer to the potential capabilities of this mode of communication, could be achieved by using different principles of operation. These will be described in a subsequent memorandum. Author

**N63-14013** White Sands Missile Range. Inter-Range Instrumentation Group, N. Mex.

**RADIO COMMAND CONTROL EQUIPMENT CATALOG, VOLUME III**

Apr. 1962 84 p
(IRIG 105-59)

Receivers, decoders, and power supply models are the equipment described in a catalog that is designed to serve as a guide to users of command control equipment. A.R.B.

**N63-14047** Watkins-Johnson Co., Palo Alto, Calif.

**THIRD MONTHLY PROGRESS LETTER Covering Period from February 1 to February 28, 1963 [DEVELOPMENT OF COUPLED CAVITY TRAVELING-WAVE TUBE AMPLIFIER FOR 1000 WATTS CW AT 35 Gc.]**

James W. Sedin Mar. 11, 1963 3 p
(Contract AF 19(628)-500)
(W-J-63-615R3)

A coupler for the amplifier circuit has been designed that has a 25-percent reflection coefficient over 80 percent of the cold passband of the circuit; and work on the mechanical design of the first amplifier has progressed to near completion. A gun which produced a .039-inch beam at 5 kv and was laminar at the beam minimum was assembled and evaluated in a demountable beam analyzer. A.R.B.

**N63-14088** Army Missile Command, Redstone Arsenal, Ala.
**PARAMETERS OF A LONG-RANGE TROPOSPHERIC FORWARD SCATTER LINK**
Roger R. Burrows Mar. 5, 1963 40 p 9 refs
(RE-TR-63-2)

The parameters of a long-range tropospheric forward scatter communication link between Redstone Arsenal and White Sands Missile Range, New Mexico, are examined for an operating frequency in L-band. An assumed transmission-path model is presented, and the diffracted and scattered fields are calculated. Expected signal-noise ratios are calculated and tabulated considering hourly, diurnal, and seasonal variations. Paraboloidal antennas are assumed and the antenna-to-medium coupling loss is calculated for a range of antenna sizes, 15 feet to 25 feet in diameter, and with frequencies from 500 to 1,000 megacycles. Author

**N63-14096** Diamond Ordnance Fuze Labs., Washington, D.C.
**THE POWER SPECTRUM PRODUCED BY THE LINEAR MIXING OF SIGNALS FREQUENCY-MODULATED BY GAUSSIAN NOISE**
Louis M. Tozzi Nov. 15, 1962 25 p 10 refs
(TR-1093)

An expression for the power spectrum of the output of a linear mixer is obtained for the case where one or both of the signals concerned are frequency-modulated by Gaussian noise. The case where one signal is a delayed replica of the reference is considered first, and the mixer output-power spectrum is given as a function of delay time. A general expression is obtained in the form of an infinite series that converges rapidly for small delay times and/or RF deviations. For large delay times, the series becomes cumbersome to handle because of its slow convergence; hence, an approximate closed-form expression is obtained. In the second case, one of the signals in the mixer is unmodulated. A closed-form approximation to the output-power spectrum is obtained in this instance. The final case considered is for both signals modulated by Gaussian noise, but with the modulation functions of each uncorrelated. Again, a closed-form approximation is obtained. Author

**N63-14106** Mitsubishi Electric Mfg. Co., Ltd. Research Lab., Amagasaki (Japan)
**INFINITELY VARIABLE FERRITE PHASE SHIFTER**
Takashi Kitsuregawa, Shojiro Nakahara, and Teruo Kondo *In its* Mitsubishi Denki Laboratory Reports, Vol. 4, No. 1 Jan. 1963 p 15-30 (See N63-14104 09-01)

This paper describes new types of ferrite phase shifters which have the continuously and infinitely variable phase shift and quick response. These are used to perform high-speed continuous beam scanning and to receive microwave power from several antennas. These infinitely variable ferrite phase shifters consist of ferrite phase shifters and ferrite switches. The structures and behaviors of various types are described. It is evident from the experimental results that the phase shifts can be varied continuously with the scanning speed of 18,000 degrees/s. The amplitude variation during the phase shift, and the phase discontinuity of the microwave power during the switching time are less than 0.3 db and 5 degrees, respectively. Author

**N63-14107** Mitsubishi Electric Mfg. Co., Ltd. Research Lab., Amagasaki (Japan)
**BROAD-BAND MATCHING OF MICROWAVE CIRCUIT**
Takashi Kitsuregawa and Seibei Tachikawa *In its* Mitsubishi Denki Laboratory Reports, Vol. 4, No. 1 Jan. 1963 p 31-50 9 refs (See N63-14104 09-01)

In this paper, the merits and demerits of various broadband matching methods of microwave circuits, which are classified by their principles, are discussed. Their applications are also described. All of these methods are very useful in practice if they are utilized according to the requirements of the cases. Author

**N63-14194** General Motors Corp. Defense Research Labs., Santa Barbara, Calif.
**RADAR ABSORPTION EFFECTS MEASURED IN A FLIGHT PHYSICS RANGE Technical Report**
H. M. Musal, Jr., P. E. Robillard, and R. I. Primich Dec. 1962 71 p 8 refs
(Contract DA-04-495-ORD-3567; ARPA Order 347-62; Proj. Defender)
(TR62-209B)

Theoretical and experimental approaches to radar absorption are discussed. The conventional theoretical approach is outlined. In the simplest model it is assumed that a metallic sphere is uniformly coated with plasma. The back-scatter cross section of this model is obtained by a geometrical optics approach. The experimental program consisted of the use of CW Doppler radars, operating at 35 gigacycles per second and 70 gigacycles per second, in measuring the radar cross section of both copper spheres and plastic cylinders with copper-covered hemispherical noses. The air pressure in the ballistic range in all cases was 10 mm of mercury, and the velocities ranged from about 10,000 fps to 20,000 fps, within which range significant absorption phenomena occurred. In the comparison with theory, anomalous absorption behavior was noted. It appeared that the measured absorption was more pronounced than could be accounted for by the theoretical model. Discussions of the possible causes of the anomalous absorption included: the possibilities of departure from equilibrium flow conditions; excitation of electro-acoustic waves; precursor ionization; radial and/or angular gradients of electron density in the nose region; and the possibility of diffraction effects for the blunt-nosed cylinder. I.v.L.

**N63-14198** Cutler-Hammer, Inc. Airborne Instruments Lab., Deer Park, N.Y.
**INTERFERENCE BLANKER GROUP AN/GPX-27()**
Paul G. Holcombe Sept. 1962 33 p
(Contract AF 30(635)-14792)
(Rept. 7318-1; RADC-TDR-62-521)

This report describes the design and development of an interference blanker or defruiting equipment that uses storage tubes to eliminate unwanted nonsynchronous signals from radar beacon video replies. It explains why a storage-tube technique was selected over delay-line techniques to perform the interference blanking function. The report gives the results of a preliminary acceptance test. Author

**N63-14199** Texas U. Electrical Engineering Research Lab., Austin
**AN APPROXIMATE SOLUTION OF THE RADIO FIELD STRENGTH IN THE VICINITY OF A GROVE OF TREES**
Alfred H. La Grone Jan. 15, 1963 50 p 6 refs
(Contract AF 19(604)-8038)
(Rept. 6-51; AFCRL-63-23)

Equations are developed for obtaining the approximate field strength in the vicinity of a grove of trees as set up by a distant transmitter. In developing the equation, the distant transmitter is replaced by an equivalent distribution of Huygen's sources. The amplitude and phase of the Huygen's sources are to be determined by conventional methods for propagation over a smooth spherical earth or they can be assumed. The grove of trees and attendant underbrush are approximated by an imperfect dielectric slab. Equations are written for all principal paths. Author

**N63-14220** Air Force Cambridge Research Labs., Bedford, Mass.
**ASPECT-SENSITIVE SPREAD AND MULTIPATH DELAY ON OFF-AZIMUTH HF ARCTIC SIGNALS LARGELY ABOVE THE MUF Research Note**
H. S. Marsh, R. A. Swirbalus, and R. J. Cormier Oct. 1962 p 184-192 6 refs Repr. from the Proc. of the 6th Natl. Conf. on Military Electronics, Washington, D.C., June 26, 1962
(AFCRL-62-777)

Signals from Fairbanks and Thule oblique HF sounders to Concord, Mass. show a large incidence at times when operating frequencies (largely 18 mcps) are above the classical MUF and reception should be impossible. Characteristic delays are much shorter than those observed on Fairbanks to Sweden observations of signals above the MUF, and tentatively explained as possibly due to layer tilt, or to lateral deviation and refraction from traveling high $foF_2$ gradients, far from the Great Circle path. The Fairbanks-Concord 18-mc signals, in particular, show a concentration of arrival in a quadrant slightly North of the Great Circle path, and centered near the bearing from Fairbanks toward the Magnetic Dip pole, within the Canadian archipelago. Here near-vertical clusters of ionization, having reflective properties comparable to meteor trails, might be expected. This dip pole area is also near the center of the permanent high of spread-F occurrence. Delays and azimuths on the Concord signals are compatible with reflection from this area, and show a high incidence of both short and long, very diffuse, continuous echo spreading, or striation, in addition to discrete multipath delays often observed. Author

# 09 ELECTRONICS

Includes: circuits and circuit theory; electronic components (e.g., tunnel diodes, transistors, and tubes); and feedback and control theory.

*For related information see:* 06 Auxiliary Systems; 08 Communications; 15 Instrumentation; 22 Navigation and Guidance; and 25 Physics, Solid-State.

**N63-13810** Ohio State U. Research Foundation. Electron Device Lab., Columbus

**INVESTIGATION OF NEW SEMICONDUCTOR PHENOMENON [Final] Report**

James Hanlon Wright-Patterson AFB, Ohio, Biomedical Lab., Apr. 1962 53 p 9 refs

(Contract AF 33(616)-8384)

(MRL-TDR-62-3) OTS: $1.25

A number of silicon, grown-junction, diffused-base transistors have been found which exhibit an abnormally high input impedance when used in the common collector amplifier circuit. These transistors are identified by peculiar notches which are found in their diode characteristics and by an increasing current gain, $h_{fe}$, at low injection levels. It is this latter phenomenon which is largely responsible for the abnormally high input impedance. These transistors have been studied through their common emitter hybrid parameters. Ways of measuring these parameters and of measuring common collector amplifier input impedance are presented. An explanation for the unusual behavior of these devices is proposed. Its basis is a small but significant variation from the normal in the doping profile of the emitter junction which produces an accelerating field at very low injection levels. Author

**N63-14000** Watkins-Johnson Co., Palo Alto, Calif.

**Technical Progress Report No. 15, 1 February through 28 February 1963 [DEVELOPMENT OF A GRIDDED 100 KW L-BAND AMPLIFIER FOR APPLICATION IN PHASED-ARRAY RADAR SYSTEMS]**

James W. Sedin Mar. 8, 1963 5 p

(Contract AF 19(628)-500)

(W-J-63-434R15)

The ceramic-barrel, grounded-cathode tube was tested with a single-reversal focusing system. The metal barrel tube was completed and processed in continuation of progress toward the development of an amplifier. A.R.B.

**N63-14014** Joint Publications Research Service, Washington, D.C.

**ARTICLES FROM SYMPOSIUM OF WORKS ON ELECTROMECHANICS**

Apr. 18, 1962 103 p Transl. of selected articles from Sbornik Rabot po Voprosam Elektromekhaniki (Moscow), no. 5, 1961

(JPRS-13512) Distributed by OTS

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**N63-14015** Joint Publications Research Service, Washington, D.C.

**AUTOMATIC CONTROL OF THE TRANSFER CHARACTERISTICS OF PHOTOELECTRIC SERVOMECHANISMS**

P. V. Nikolayev *In its* Articles from Symposium of Works on Electromechanics Apr. 18, 1962 p 1-22 5 refs (See N63-14014 09-09)

A photoelectric servomechanism is described which incorporates automatic control of the transfer characteristics and enables stars to be tracked even when their brightness varies by a factor of several thousand. The advantages of this mechanism are the elimination of the usual half-disk modulator for the light flux and the elimination of "fatigue" of the electron multiplier. R.C.M.

**N63-14016** Joint Publications Research Service, Washington, D.C.

**CONTINUOUS CONTROL SYSTEM ENSURING THE OPERATION OF A TELESCOPE AT A GIVEN PROGRAM**

Z. N. Mamedova *In its* Articles from Symposium of Works on Electromechanics Apr. 18, 1962 p 23-45 (See N63-14014 09-09)

Programed tracking systems are discussed as to their possible application for aiming astronomical telescopes. Both digital and analog systems are considered. The servomechanism and transformers necessary for these systems are considered along with the circuits required to correct for atmospheric refraction. R.C.M.

**N63-14017** Joint Publications Research Service, Washington, D.C.

**USE OF MAGNETIC ELEMENTS IN CODE-TYPE TELEMETRY SYSTEMS**

V. Ye. Charuyshev *In its* Articles from Symposium of Works on Electromechanics Apr. 18, 1962 p 46-58 5 refs (See N63-14014 09-09)

The existing types of contactless memory elements are compared to prepare recommendations for the use of memory cells in code-type

telemetry systems. Conclusions are drawn as follows: cells for code telemetering systems should be semiconductor devices and ferrites; and the memory units should be constructed of purely logical-pulse cells. R.C.M.

**N63-14018** Joint Publications Research Service, Washington, D.C.
**CONCERNING THE PROBLEM OF DESIGN OF COMPLEX DEVICES FOR THE TRANSMISSION OF INFORMATION WITH CENTRALIZED CONTROL**
M. I. Lanin *In its* Articles from Symposium of Works on Electromechanics Apr. 18, 1962 p 59-71 7 refs (See N63-14014 09-09)

The methods of constructing messages are analyzed to point out the conditions necessary for their use. The methods include: (1) Object Method—contains information in the transition of any object into some new state; (2) Circular Method—includes information on the states of all remaining objects; and (3) Group Method—contains information of the states of objects during transmission. R.C.M.

**N63-14019** Joint Publications Research Service, Washington, D.C.
**NUMERICAL AND COMBINATIONAL METHODS FOR CODING INFORMATION**
V. I. Filippov *In its* Articles from Symposium of Works on Electromechanics Apr. 18, 1962 p 72-90 4 refs (See N63-14014 09-09)

A number-combination method of coding is described for use with memory cell readers utilizing shifting registers with logical feedback. This method is shown to be most effective when it is necessary to convert a large volume of information without increasing the size or the power consumption of the coder. R.C.M.

**N63-14020** Joint Publications Research Service, Washington, D.C.
**MEASURING INSTRUMENTS AND ELEMENTS OF AUTOMATIC AND TELEMETERING SYSTEMS. ELECTRONIC INSTRUMENTS FOR ANALYSIS OF BIOELECTRIC CURRENTS**
S. A. Yevdokimov, V. V. Semenov, G. N. Sokolov, and V. A. Tarasov *In its* Articles from Symposium of Works on Electromechanics Apr. 18, 1962 p 91-100 2 refs (See N63-14014 09-09)

Biological instruments have been developed to simplify physiological investigations and partially automatize the reduction of data. The following units are included: biocurrent amplifiers; filters for biocurrents: integrators for biocurrents; setup field for connecting the filter and integrator as needed; calibrating generator for determining the frequency and amplitude of biocurrents; and program unit for studying conditioned reflexes. R.C.M.

**N63-14210** National Aeronautics and Space Administration, Washington, D.C.
**TRANSISTORIZED VOLTAGE STABILIZER (STABILIZATOR NAPRYAZHENIYA NA POLUPROVODNYKH ELEMENTAKH)**
I. M. Gershuni and A. N. Karaulov Apr. 1963 14 p 2 refs Transl. by Faraday Translations from Tsifrovaya Tekhn. i Vychislitel'nye Ustroystva (USSR), no. 3, 1962 p 110-115
(NASA TT F-155) OTS: $0.50

A seven-transistor voltage stabilizer with an output power of about 25 watts is described. Due to a relatively high amplification factor and the use of a current-stabilizing two-terminal network, the circuit insures a stabilization factor of the order of $2 \cdot 10^3$ to $3 \cdot 10^3$, the corresponding output resistance being not more than 0.005 ohm. By introducing a feedback coupling into the balancing stage of the amplifier, it is possible to limit the drift in output voltage associated with temperature changes to 3.3 mv/degree. Author

**N63-14219** Air Force Cambridge Research Labs. Electronics Research Directorate, Bedford, Mass.
**THE MATERIAL LIMITATIONS OF TUNNEL DIODE COMMUNICATIONS CIRCUIT PERFORMANCE Research Report**
F. D. Shepherd, Jr., A. C. Yang, and V. Vickers Jan. 1963 24 p 13 refs
(AFCRL-63-2)

The tunnel diode is studied with the goal of determining those basic material parameters that affect its ultimate operation as a communications circuit element. In particular, expressions for gain-bandwidth product, noise figure, and maximum frequency of oscillation are derived in terms of a material's dielectric constant, carrier effective masses, forbidden gap energy, mobilities, and impurity densities. The resulting figures of merit for a material are discussed in terms of several semiconductors. The result is a set of selection criteria, by which contemporary materials may be evaluated in terms of a particular application requirement, and by which new materials may be evaluated in terms of their possible use as a tunneling medium. Author

# 10 FACILITIES

Includes: airports; lunar and planetary bases; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands and wind tunnels); test ranges; and tracking stations.

*For related information see:* 06 Auxiliary Systems.

**N63-13840** Northrop Corp. Nortronics Div., Hawthorne, Calif.
**Q-BALL TEST AND CALIBRATION PROCEDURES (USING TF-16 ELECTRONIC AND PNEUMATIC ANALYZERS)**
F. C. Corey Dec. 6, 1962 18 p
(NORT-62-412; F-16)

Operating procedures are given for the TF-16 electronic and pneumatic analyzers. R.C.M.

**N63-13984** Southampton U. (Gt. Brit.)
**PROGRESS REPORT ON THE UNIVERSITY OF SOUTHAMPTON LOW DENSITY ARC HEATED WIND TUNNEL Technical Note No. 14**
B. Makin Aug. 1962 58 p 5 refs
(Partially supported by USAF)
(AASU-227)

A low-density arc-heated wind tunnel has been constructed and operated on argon and nitrogen. The purpose of this report is to explain the development of the facility and present its performance characteristics. Author

**N63-14034** General Motors Corp. Aerospace Operations Dept., Santa Monica, Calif.
**INSTRUMENTATION, CALIBRATION, AND DATA REDUCTION METHODS**
W. L. Koch, comp. Dec. 1962 194 p 12 refs
(Contract DA-04-495-ORD-3567; ARPA Order 347-62; Proj. Defender)
(TR-62-213)

The instrumentation and procedures of the Flight Physics Range are described as follows: gas gun and models; spark photography apparatus; flight kinematics; computation of constants and analysis of error in equation of motion; model impact on reflector plane; flash X-ray photography; schlieren system; optical radiation measurements; infrared radiation instrumentation; transverse path microwave absorption; and continuous-wave doppler radars to measure the radar cross section of hypersonic models. R.C.M.

**N63-14055** Southampton U. (Gt. Brit.)
**THE UNIVERSITY OF SOUTHAMPTON RANDOM SIREN FACILITY [Summary] Technical Documentary Report [Dec. 1961-Dec. 1962]**
B. L. Clarkson and S. A. Pietrusewicz Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, Jan. 1963 40 p 5 refs
(Contract AF 61(052)-504)
(ASD-TDR-63-91)

This report describes the construction and performance of the Southampton University Random Siren Facility. The configuration is of the grazing-incidence type designed to take specimens 3 ft. × 2 ft. The maximum noise level which can be achieved in the working section is 150 db in the random mode of operation and somewhat higher for discrete frequencies. The noise source is an electromagnetic air modulator capable of broadband response in the frequency range up to 800 to 1000 cps. A lower frequency limit of 110 cps is imposed by the exponential horn. Thus a noise pressure spectrum approximating that associated with jet noise can be obtained. Author

**N63-14100** National Aeronautics and Space Administration, Washington, D.C.
**FAA, NASA JOIN IN SUPERSONIC TRANSPORT SIMULATOR PROGRAM News Release No. 63-53**
Mar. 14, 1963 53 p
Available from NASA. Office of Scientific and Technical Information, Wash., D.C.

The Federal Aviation Agency and the National Aeronautics and Space Administration are completing plans for a joint study of supersonic transport operation within existing and future air traffic control environments. This research program has a twofold purpose. It will provide data for (1) design and operation of a supersonic transport that is compatible with an evolving air traffic control system, and (2) definition of the requirements for an air traffic control system to handle supersonic commercial air transports. Four different aircraft concepts will be examined within various air traffic environments that will simulate today's system and a modified system to represent the traffic mix and control complex expected in the 1970's. The NASA ground-based simulator to be located at Langley will have a cockpit arranged like that of a modern subsonic jet transport with accommodations for a four-man crew, a communication system, and instrumentation modified for the higher speed and altitude range of the supersonic transport. I.v.L.

# 11 FLUID MECHANICS

Includes: boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence.

*For related information see:* 02 Aerodynamics of Bodies, Combinations, and Internal Flow, 03 Aerodynamics of Wings and Control Surfaces; 13 Heat Transfer; and 24 Physics, Plasma.

**N63-13787** Aeronautical Research Council (Gt. Brit.)
**FURTHER RESULTS ON THE MIXING OF FREE AXIALLY-SYMMETRICAL JETS OF MACH NUMBER 1.40**
N. H. Johannesen (Manchester U.) London, HMSO, 1962 28 p 7 refs
(ARC-R&M-3292; previously issued as ARC-20981) Available from HMSO: 11s.

An axially-symmetrical supersonic fully-expanded jet of diameter 0.75 in. was investigated by pitot- and static-tube traverses in the region from the exit to 100 diameters downstream. In the jet discussed in this report the initial internal disturbances were weak, as compared with those in the jet investigated previously. The structures of the mixing regions in the initial parts of the two jets showed substantial differences. Further downstream the jet with weak internal disturbances showed a very slow approach to self-preserving flow. This was clear from the curves of the jet width and of the reciprocal of the centerline velocity plotted against distance from the exit approaching straight lines only slowly, but was particularly clearly indicated by the static-pressure distributions. The ratio of static pressure to dynamic pressure showed no tendency to become constant on the axis, even at the last station of measurement. The relation between the static-pressure distributions and the jet turbulence is discussed, and it is shown that if the classical corrections to the readings of pitot and static tubes are adequate, the errors in the deduced structure of the jet, ignoring these corrections may be very considerable. Author

**N63-13792** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**SURFACE PRESSURE DISTRIBUTIONS INDUCED ON A FLAT PLATE BY A COLD AIR JET ISSUING PERPENDICULARLY FROM THE PLATE AND NORMAL TO A LOW-SPEED FREE-STREAM FLOW**
Raymond D. Vogler Washington, NASA, Mar. 1963 33 p 6 refs
(NASA TN D-1629) OTS: $1.00

An investigation was made to determine the pressure distribution on the surface of a flat plate induced by a round cold-air jet and a rod. Data are presented as pressure-coefficient contours on the plate for various jet and free-stream velocities associated with transition flight speeds of VTOL aircraft. The jet produces a region of positive pressures upstream of the jet and a larger region of negative pressures laterally and downstream of the jet. This negative pressure field extends 8 or 10 jet diameters from the jet, is intensified by an increase in jet velocity, and is swept downstream by an increase in free-stream velocity. Author

**N63-13800** California Inst. of Tech. Div. of Engineering and Applied Science, Pasadena
**BUBBLE DYNAMICS**
Milton S. Plesset Feb. 1963 31 p 12 refs
(Contract Nonr-220(28))
(Rept. 85-23)

A résumé is given of recent developments in the theory of bubble dynamics. Among the problems considered is the effect of heat flow on vapor bubble growth or collapse, and the theoretical results are described in physical terms. Similarly, a physical description is given of the first-order thermal effects in gas bubbles in oscillating pressure fields. The theory of the second-order process of mass rectification for oscillating gas bubbles is also reviewed. The final topic discussed is the stability of the spherical shape of a bubble during expansion or contraction. Author

**N63-13803** Aeronautical Research Council (Gt. Brit.)
**THE MIXING OF FREE AXIALLY-SYMMETRICAL JETS OF MACH NUMBER 1.40**
N. H. Johannesen (Manchester U.) London, HMSO, 1962 33 p 15 refs
(ARC-R&M-3291; previously issued as ARC-18967) Available from HMSO: 12s. 6d.

Axially-symmetrical, supersonic, fully-expanded jets of diameter about 0.75 in. and of Mach number 1.40 issuing into an atmosphere at rest were investigated by schlieren and shadow photography and by pressure traversing. The development of the jets was found to depend critically on the strength of the shock waves in the core of the jet at the nozzle exit. With strong shock waves present the jet spread very rapidly and was very unsteady. The jet did in some cases break up into large eddies of the same size as the diameter of the jet. When no disturbances were present in the core of the jet the spreading was

far more gradual and the jet showed only slight unsteadiness. The turbulent mixing region of the first part of the jet with strong shock waves was investigated in detail by pitot tubes. The first inch was found to correspond to a two-dimensional half-jet. The velocity profiles were similar and well represented by the error integral. The rate of spreading was only half the value for low-speed flow. By integrations across the mixing region the entrainment and the loss of kinetic energy were determined. These quantities were found to agree well with the values estimated by assuming an error-integral velocity profile. Author

**N63-13813** Fairchild Stratos Corp. Aircraft-Missiles Div., Hagerstown, Md.

**REAL GAS OBLIQUE SHOCK FUNCTIONS FOR AIR IN CHEMICAL EQUILIBRIUM**

Allen B. Walburn and Paul Harner Dec. 14, 1962 25 p 8 refs (Data Memo. 63-1)

Charts are presented for oblique-shock relations at hypersonic Mach numbers for real air in thermal and chemical equilibrium. Additional charts are presented which define the temperature, enthalpy, pressure, and density variation of air with altitude as delineated by the ARDC Model Atmosphere, 1959, and which define the relationship between the hypersonic similarity parameter and the shock-wave deflection parameter for both two-dimensional (wedge) and three-dimensional (conical) flow. The altitudes chosen for delineation on the oblique-shock charts are those which depict the isothermal boundaries described by the model atmosphere. The oblique-shock relationships are given for altitudes from sea level to 299,000 feet. The air properties downstream of the shock wave account for variable specific heat as well as molecular dissociation and ionization. Author

**N63-13831** Boeing Scientific Research Labs., Seattle, Wash.

**A STUDY OF THE SLENDER BODY OF REVOLUTION OF MINIMUM DRAG USING THE NEWTON-BUSEMANN PRESSURE COEFFICIENT LAW**

Angelo Miele [1962] 55 p 9 refs Presented at *its* Symposium on External Problems in Aerodynamics, Seattle, Dec. 3-4, 1962

This paper presents an investigation of the problem of minimizing the drag of a slender body of revolution in hypersonic flow under the assumption that the pressure coefficient law is Newton's impact law as modified by Busemann in order to include centripetal acceleration effects. The minimal problem is formulated as a problem of the Mayer type and solved by the combined use of the Euler-Lagrange equations, the transversality condition, the Erdmann-Weierstrass corner conditions, and the properties of the switching function. Particular attention is devoted to the class of solutions such that, among the four quantities being considered (the diameter, the length, the wetted area, and the volume), two are prescribed while the remaining are free. For these problems, the extremal arc is composed of two subarcs: one of them is characterized by a positive pressure coefficient and is called the regular shape; the other is characterized by zero pressure coefficient and is called the free layer. Author

**N63-13846** Aeronautical Research Council (Gt. Brit.)

**LAMINAR MIXING OF A NON-UNIFORM STREAM WITH A FLUID AT REST**

J. F. Nash London, HMSO, 1962 19 p 5 refs
(ARC-CP-613; previously issued as ARC-22245) Available from HMSO: 3s.

A theoretical analysis is made of the constant-pressure laminar mixing process between a stream having an initial boundary-layer velocity profile and a fluid at rest. The present theory follows the methods of W. Tollmien and S. I. Pai with certain modifications. The results apply to incompressible flow, but can be extended to the compressible case without difficulty. Author

**N63-13847** Aeronautical Research Council (Gt. Brit.)

**QUALITATIVE SOLUTION OF THE STABILITY EQUATION FOR A BOUNDARY LAYER IN CONTACT WITH VARIOUS FORMS OF FLEXIBLE SURFACE**

T. Nonweiler (Queen's U.) London, HMSO, 1963 76 p 9 refs
(ARC-CP-622; previously issued as ARC-22670) Available from HMSO: 10s.

An appropriate form of the boundary-layer stability equation is developed for the condition where the fluid is in contact with an isotropic and homogeneous elastic medium, and various approximate analytical solutions obtained for certain types of surface, so as to reveal, at least qualitatively, the origin and characteristics of neutral oscillations. In the worked solutions, the elastic medium is treated as nondissipative, and the interior boundary is supposed either fixed, or free of stress, or exposed to fluid; the boundary layer, also, is treated as that over a flat-plate in an incompressible fluid. The results obtained show that the presence of such a resilient surface introduces the possibility of a number of other modes of oscillation (over the complete Reynolds-number range) apart from those of Tollmien-Schlichting waves. Most of these modes have speeds of propagation determined largely by the properties of the elastic material, and their presence may well be effectively a matter of nonviscous flow stability—a subject not treated here. The Tollmien-Schlichting mode has its minimum Reynolds number increased by the presence of the surface, but if the interior boundary is free there may be an upper limit as well. A sufficiently thin free surface, or one of low rigidity, apparently eliminates neutral oscillations of this mode altogether, only at the expense, however, of the introduction of a mode of flexural waves. Author

**N63-13848** Aeronautical Research Council (Gt. Brit.)

**SOME CHARACTERISTICS OF RECTANGULAR MULTI-SHOCK AND ISENTROPIC EXTERNAL COMPRESSION INTAKES AT A MACH NUMBER OF 2.9**

R. A. Dutton and E. L. Goldsmith London, HMSO, 1963 34 p 4 refs
(ARC-CP-630; previously issued as RAE-TN-AERO-2786, ARC-23440) Available from HMSO: 5s.

Pressure recovery and mass flow have been measured for a number of rectangular air intakes having single-shock, multishock, and isentropic external compression surfaces at a Mach number of 2.9 and Reynolds number of $2.25 \times 10^5$ (based on entry height). For one intake having a multishock compression surface, the effect of throat boundary-layer bleeds on the variation of pressure recovery with mass flow was investigated. Measured pressure recoveries varied from 5% to 20% below the calculated shock-wave recovery value when employing the maximum permissible amount of internal contraction (i.e., that which will just allow the intake to "start"). Variation of the internal contraction was found to have an appreciable influence on pressure recovery. With the best throat boundary-layer bleed tested, the pressure recovery was increased by 10% over that without bleed. Measured pressure recoveries have been used to calculate thrusts for comparative hypothetical ramjets. These have been combined with calculated external cowl drags for the different configurations to produce specific fuel-consumption values for a given thrust minus drag. Author

**N63-13856** Aeronautical Research Council (Gt. Brit.)

**THE USE OF CONICAL CAMBER TO PRODUCE FLOW ATTACHMENT AT THE LEADING EDGE OF A DELTA WING AND TO MINIMIZE LIFT-DEPENDENT DRAG AT SONIC AND SUPERSONIC SPEEDS**

J. H. B. Smith and K. W. Mangler London, HMSO, 1963 32 p 15 refs
(ARC-R&M-3289; previously issued as RAE-AERO-2584, ARC-19961) Available from HMSO: 13s. 6d.

In an attempt to avoid flow separation at the leading edge of a thin delta wing with subsonic leading edges, an attachment line is prescribed there. This is done by requiring the load, as predicted by

attached-flow theory, to vanish along the leading edge at the design lift coefficient. For sonic speed, a complete account of this flow is given in terms of slender-wing theory, and the load distributions corresponding to arbitrary conical camber are calculated. For supersonic speeds, load distributions arising in the slender-wing theory are considered, and the corresponding conical-camber distributions are found by linearized theory. The lift-dependent drag for a given lift is then minimized with respect to the coefficients of a linear combination of these load distributions. It is found that the lift-dependent drag factor for these conically cambered wings approaches the value it takes for the attached flow (in which leading-edge suction occurs) past the uncambered wing at the same Mach number, as more terms are included in the linear combination. However, when the leading edge is almost sonic, an appreciable reduction is predicted. The corresponding load distributions and wing shapes are calculated and drawn. The optimum shapes for a fixed number of terms resemble flat plates drooped downwards near their leading edges, so that the localized leading-edge suction is replaced by a distributed force on a forward-facing surface, producing an effect of similar magnitude. Author

**N63-13891** National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.

**MODEL INVESTIGATION OF WATER LANDINGS OF A WINGED REENTRY CONFIGURATION HAVING OUTBOARD FOLDING WING PANELS**

William W. Petynia Washington, NASA, Dec. 1959 20 p 4 refs
(NASA TM X-62) OTS: $1.60 ph, $0.80 mf (Declassified)

An investigation has been made to determine the water-landing characteristics of a winged reentry configuration. The all-wing configuration had a delta wing with a leading-edge sweep of 63°, extendable outboard wing panels, small retractable hydroskis, and a tail skid. Smooth-water landings were made over a range of landing angle of attack from 7° to 16°. In addition, landings were made with yaw and roll. A few landings were made in waves. The hydrodynamic longitudinal and lateral stability were good at all landing conditions investigated. The landing run was between 300 and 400 feet. Maximum normal and longitudinal accelerations occurred during the first impact of the hydroskis and were approximately 2½ g and 2g, respectively. The accelerations during landings in small waves were approximately twice as great as those in smooth water. The upper surface of the model was essentially clear of spray for all landing conditions, although heavy spray from the hydroskis struck the undersurface of the wing. Author

**N63-13949** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

**EFFECTS OF AIR CONTENT AND WATER PURITY ON LIQUID TENSION AT INCIPIENT CAVITATION IN VENTURI FLOW**

Robert S. Ruggeri and Thomas F. Gelder Washington, NASA, Mar. 1963 46 p 7 refs
(NASA TN D-1459) OTS: $1.25

Cavitation of demineralized, tap, and distilled water was induced on the walls of a venturi having a 1.377-inch throat diameter in a closed-return liquid tunnel. The occurrence and magnitude of local tensile stresses in the liquid at incipient-cavitation conditions were studied over a range of air content. Local tensile stresses at incipience of visible cavitation were independent of water type and air content, and ranged from 5 to 23 feet of water for free-stream velocities from 20 to 45 feet per second, respectively. Tensile stresses at incipience of audible cavitation varied considerably with air content of the water but were generally less than those obtained at the visible threshold. Visible incipient cavitation was of the fixed type and always occurred as a practically instantaneous burst of vapor bubbles in the region of minimum pressure. Venturi cavitation was unsteady for all degrees of cavitation and stream velocities studied. Author

**N63-13979** California Inst. of Tech. Graduate Aeronautical Labs., Pasadena

**THE EFFECT OF AN IDEALIZED BOUNDARY LAYER ON FLUTTER OF CYLINDRICAL SHELLS IN SUPERSONIC FLOW**

William J. Anderson and Y. C. Fung Dec. 1962 69 p 11 refs
(Supported by AFOSR)
(SM-62-49)

The effect of boundary-layer flow on the flutter of a thin, circular, cylindrical shell in a uniform supersonic flow parallel to the cylinder axis is studied. The aerodynamic forces are developed for a shell of infinite length. The boundary layer is idealized as an annular region of uniform parallel subsonic flow surrounding the shell. The boundary-layer velocity profile is therefore discontinuous, in the form of a step function. Perturbations due to wall oscillations are assumed to be small, so that the flows in the subsonic and supersonic regions are isentropic and irrotational, with the concentrated vortex layer at the interface between the supersonic and subsonic regions serving the function of boundary layer. In this report, linear piston theory is used for the supersonic flow; therefore, the results are applicable only at high Mach numbers. In general, the boundary layer has a relatively small effect on the flutter in symmetric modes, but it is significantly stabilizing for "scallop" modes with many circumferential nodes. Author

**N63-14003** Aro, Inc., Arnold Air Force Station, Tenn.

**A COMPARISON OF TRANSITION REYNOLDS NUMBERS FROM 12-IN. AND 40-IN. SUPERSONIC TUNNELS**

C. J. Schueler Arnold Engineering Development Center, Mar. 1963
21 p 10 refs
(Contract AF 40(600)-1000)
(AEDC-TDR-63-57)

Transition Reynolds number measurements on a hollow cylinder in the von Kármán Gas Dynamics Facility's 12-in. and 40-in. supersonic tunnels show that the highest transition Reynolds numbers were obtained in the 40-in. tunnel, although the variations with unit Reynolds number were the same at Mach numbers 3 to 5. The influence of nose bluntness in the 40-in. tunnel corresponds closely to the results obtained in the 12-in. tunnel. Author

**N63-14031** General Motors Corp. Defense Research Labs., Santa Barbara, Calif.

**PRELIMINARY MEASUREMENTS OF OPTICAL RADIATION FROM BOUNDARY LAYER FLOW ABOUT HEMISPHERE-CYLINDER BODIES AT 5.2 KM/SEC Technical Report**

W. R. Leak and G. A. Shaw Dec. 1962 28 p 10 refs
(Contract DA-04-495-ORD-3567; ARPA Order 347-62; Proj. Defender)
(TR62-209E)

Polyethylene models, three calibers in length, were flown at velocities around 5.2 km/sec in air at 10 mm Hg, with angles-of-attack less than 4 degrees. Visible radiation from along the body was measured and found to be about the same magnitude as that observed in the wake under the same viewing conditions. The total radiation along the body is 2 to 3 times greater than that from the stagnation region. Compared with both experimental and theoretical values for pure air, the radiation from the plastic models is high by an order of magnitude, which is attributed to the addition of the ablation products. Author

**N63-14032** General Motors Corp. Defense Research Labs., Santa Barbara, Calif.

**EQUILIBRIUM STAGNATION REGION RADIATION FROM PURE AIR FOR THE 0.2 - 1.0μ BAND Technical Report**

C. F. Hansen and W. R. Leak Dec. 1962 32 p 12 refs
(Contract DA-04-495-ORD-3567; ARPA Order 347-62; Proj. Defender)
(TR62-209F)

Measurements of the radiation from clean, equilibrium air in the stagnation region of high-velocity models are reported. The

models are copper-clad, plastic spheres flying at velocities from 3 to 7.3 km/sec through air at 10mm pressure. The radiation is measured for bands lying within the spectrum from 0.2 to 1.0 micron. Measured values agree well with theoretical predictions. Author

**N63-14033** General Motors Corp. Defense Research Labs., Santa Barbara, Calif.

**INFRARED RADIATION FROM LOW ABLATING HYPERVELOCITY BODIES Technical Report**

C. J. Maiden and M. Steinberg Dec. 1962 37 p 9 refs
(Contract DA-04-495-ORD-3567; ARPA Order 347-62; Proj. Defender)
(TR62-209G)

The infrared radiation from 1 to 5.5 microns associated with the flight of copper-coated models has been measured in a free-flight range. Two types of models have been studied, copper-clad spheres and plastic cylinders with copper-coated nose sections (standard models). In all tests, the free-stream pressure was 10 mm and the test velocities ranged from 12,000 to 23,000 ft/sec (4.86 to 7.0 km/sec). Wavelength bands of 1 to 5.5, 2 to 3, 3 to 4, and 4 to 5 microns have been studied. The results obtained with spheres indicate that the majority of the observed radiation was produced at wavelengths below 2 microns. This emission is thought to be associated with the $N_2$ (1+) band and with transitions between the excited states of nitric oxide. Above 2 microns, free-free transitions of electrons in the gas cap appear to be the main source of radiation. There is some deviation from this result in the 2 to 3 micron bandwidth at low velocities. The results from the copper-capped standard model experiments are consistent with many of the conclusions obtained for spheres. However, there is evidence of ablation products from the polyethylene sides of the model producing a significant amount of radiation, relative to gas cap radiation, particularly at low velocities. Author

**N63-14041** Massachusetts Inst. of Tech. Aerophysics Lab., Cambridge

**AN ANALYTICAL INVESTIGATION OF CAVITY OSCILLATIONS. CAVITIES WITH UNOBSTRUCTED OPENINGS AND DISCONTINUOUS VELOCITY PROFILE**

Eugene E. Covert Oct. 1962 70 p 20 refs
(Contract Nonr-1841(79))
(Tech. Rept. 38; MIT-DSR-8951)

The oscillations of a cavity are studied from the standpoint of the hydrodynamic stability of the process. It is found that the fundamental frequencies correspond to particular energy-storage elements in the system. The calculations are based upon an inviscid-fluid model with a discontinuity in tangential velocity at the cavity interface. This model seems to exhibit most of the features observed in experiments. Author

**N63-14071** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

**THE LAMINAR BOUNDARY LAYER NEAR THE LEADING EDGE OF A FLAT PLATE**

O. T. Hanna [1961] 15 p 8 refs
OTS: $1.60 ph, $0.80 mf

The skin friction and boundary-layer thickness for laminar flow near the leading edge of a flat plate have been determined by means of the integral momentum equation. The calculated skin friction is in excellent agreement with experimental data in the range $3 < N_{Re_L} < 2000$, as well as with linearized calculated results in the range $0.1 < N_{Re_L} < 4$. It is shown that these skin-friction results may also be used to determine liquid-metal heat transfer near the leading edge of a flat plate. Author

**N63-14099** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

**STRUCTURE OF A PLANE SHOCK LAYER**

H. W. Liepmann, R. Narasimha, and M. T. Chahine Repr. from the Physics of Fluids, v. 5, no. 11, Nov. 1962 p 1313-1324 22 refs (NASA Contract NAS7-100; NASA Grant NsG-40-60; Contract Nonr-220(21))

The structure of a plane shock wave is discussed, and the expected range of applicability of the Navier-Stokes equations within the shock layer is outlined. The shock profiles are computed using the Bhatnagar-Gross-Krook model of the Boltzmann equation and a uniformly converging iteration scheme starting from the Navier-Stokes solution. It is shown that the Navier-Stokes solution remains a good approximation in the high-pressure region of the shock layer up to approximately the point of maximum stress for all shock strengths. In the low-pressure region, the correct profiles deviate with increasing shock strength from the Navier-Stokes solution. The physical significance of the kinetic model used, and the relation of the present study to previous theoretical and experimental work is discussed. Author

**N63-14109** Mitsubishi Electric Mfg. Co., Ltd. Research Lab., Amagasaki (Japan)

**UNIVERSAL SHOCK TUBE**

Katsuhiro Akashi, Haruo Saito, and Masahiro Sugihara *In its* Mitsubishi Denki Laboratory Reports, Vol. 4, No. 1 Jan. 1963 p 65-100 2 refs (See N63-14104 09-01)

A shock tube has been designed which is adaptable to a wide range of experiments. Author

**N63-14190** Naval Weapons Lab., Dahlgren, Va.

**STAGNATION AND WAKE FLOWS, NORMAL TO A FLAT SURFACE**

Ernst W. Schwiderski and Hans J. Lugt Feb. 1963 47 p 4 refs (NWL-1840)

Complete numerical results of axisymmetric and plane stagnation and wake flows, which are produced by homogeneous motions with finite initial velocities normal to a flat surface, are presented for a variety of Reynolds numbers. The results have been obtained on the basis of an extension of Prandtl's boundary layer theory. Characteristic flow properties are pointed out and discussed. Critical Reynolds numbers for nonexistent laminar attached flows are computed. Author

**N63-14200** Bureau of Mines. Helium Research Center, Amarillo, Tex.

**SUPERCOMPRESSIBILITY FACTORS FOR HELIUM-NITROGEN MIXTURES**

John E. Miller and Lowell Stroud 1963 246 p 4 refs
(BM-RI-6192)

Supercompressibility factors, $F_{pv}$, were derived from experimental compressibility data for five helium-nitrogen mixtures containing from 50% to 100% helium. These $F_{pv}$ values are required as volumetric correction factors for orifice meter measurement of "crude helium" (Helium-nitrogen). Although compressibility measurements were made by the Burnett method for pressures from 100 to 3,400 psia and temperatures from 40° to 100° F, $F_{pv}$ values were needed only for pressures from 400 to 2,000 psia. Consequently, values at increments of 2° F, 2% helium, and 10 psia were tabulated only for the required pressure range. Values for pressures outside this range can be calculated from information shown in the tables. Values for the second, third, and fourth coefficients in the equation $Z = 1 + BP + CP^2 + DP^3$ are also included. Author

**N63-14202** Sandia Corp., Albuquerque, N. Mex.

**TURBULENT MIXING OF AXISYMMETRIC COMPRESSIBLE JETS (IN THE HALF-JET REGION) WITH QUIESCENT AIR**

R. C. Maydew and J. F. Reed Mar. 1963 56 p 32 refs
(Supported by AEC)
(SC-4764(RR)) OTS: $1.25

Velocity profiles at five axial stations in the half-jet mixing region of Mach 0.7, 0.85, 0.95, 1.49, and 1.96 free jets were measured. The nondimensional velocity distributions are similar, and correlate with the theory of Crane for incompressible flow. The half-jet spreading rate is essentially constant at subsonic speeds and decreases at supersonic speeds. The variation of jet spreading parameter with Mach number was determined from correlation of these and other data. Author

**N63-14207** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

**AN EXTENSION OF ESTIMATED HYPERSONIC FLOW PARAMETERS FOR HELIUM AS A REAL GAS**

Wayne D. Erickson Washington, NASA, Apr. 1963 23 p 5 refs
(NASA TN D-1632) OTS: $0.75

The various hypersonic flow parameters for helium have been estimated by use of the Beattie-Bridgeman equation-of-state for helium at stagnation pressures up to 50,000 lb/sq in. abs and stagnation temperatures up to 10,000° F. Calculations were limited to densities below the critical density. The results were obtained to establish reasonable estimates of the departure from ideal-gas behavior over a broad practical range of stagnation pressure and temperature at Mach numbers up to 100. The results are presented as correction factors which are to be applied to ideal-gas parameters for a specific-heat ratio of 5/3. Author

**N63-14208** General Dynamics Corp. John Jay Hopkins Lab. for Pure and Applied Sciences, San Diego, Calif.

**THE KINETICS OF VAPORIZATION BELOW THE CRITICAL POINT**

W. G. Vulliet Dec. 14, 1962 10 p 5 refs Submitted for Publication
(Contract AF 29(601)-2207)
(GA-3633)

An equation relating some thermodynamic variables on each side of a vaporizing liquid surface is derived from the principles of statistical mechanics and irreversible thermodynamics. This relation and the usual hydrodynamic conservation theorems, along with the boundary conditions, form a simultaneous set of equations which completely describe the thermodynamic properties of the liquid and vapor. Author

# 12 GEOPHYSICS

Includes: auroral phenomena; upper atmospheric studies; cartography; geodesy; and geomagnetism.

*For Van Allen belts see:* 28 Space Radiation.

*For related information see:* 05 Astronomy and Astrophysics; 21 Meteorology; and 29 Space Sciences.

**N63-13821** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

**THE MAGNETIC FIELD OF THE QUIET-TIME PROTON BELT**

Syun-Ichi Akasofu, Sydney Chapman (Alaska U.), and Joseph C. Cain Washington, NASA, Mar. 1963 7 p 4 refs Previously announced as a preprint, see N63-11783 04-12
(NASA TN D-1674) OTS: $0.50

The distortion of the earth's magnetic field produced by the proton belt is discussed. The magnetic field is calculated numerically, to a first approximation, for an analogous model belt, in a steady state. In the equatorial plane, at the earth's surface, it is estimated that the magnetic field produced by this belt is of the order of 38 gammas; it is directed southward. The maximum field reduction is of the order of 72 gammas at 4.1 earth radii; this is 15.5 percent of the dipole field intensity at this point. Beyond 6.7 earth radii, the belt increases the earth's field. Author

**N63-13836** Council of Scientific & Industrial Research. Radio Research Committee, New Delhi (India)

**IONOSPHERIC DATA**

Apr. 1962 57 p 2 refs
(RRC-A83)

Ionospheric data from a chain of eight stations in India are tabulated for April 1962. Seven of these stations are in the 75° E longitude zone, and the observations cover a range of geomagnetic latitudes from 19.2° N to 0.9° S. M.P.G.

**N63-13837** Council of Scientific & Industrial Research. Radio Research Committee, New Delhi (India)

**IONOSPHERIC PREDICTIONS FOR MAY 1963**

Dec. 1962 4 p
(RRC-B80)

The predicted median values are given for the ordinary ray critical frequencies and for the maximum usable frequencies for 4000 km. These are given for the East Zone during May 1963. R.C.M.

**N63-13838** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

**FIRST TOPSIDE SOUNDINGS OF THE IONOSPHERE**

J. E. Jackson, R. W. Knecht (Natl. Bur. of Standards), and S. Russell (Cutler Hammer. Airborne Instr. Lab.) Washington, NASA, Mar. 1963 18 p 6 refs
(NASA TN D-1538) OTS: $0.50

The first radio-pulse soundings of the topside of the ionosphere were obtained during two recent rocket flights at the NASA Wallops Island, Virginia, facility. These tests are part of the NASA topside sounder satellite program, whose primary objective is to investigate the ionosphere above the height of the F2 maximum. On June 24, 1961, a two-frequency radio-pulse sounder was carried to an altitude of about 1060 km by a four-stage solid-propellant rocket. Reflections from the topside of the ionosphere were obtained on one or both frequencies during 13 of the 15 minutes the payload was above the maximum electron density level in the ionosphere. Unexpected effects were observed as the sounder passed through the levels in the ionosphere where the plasma frequency was equal to the sounding frequency; some evidence of ionization irregularities at altitudes between 700 and 950 km was obtained. A second rocketborne sounder was launched during disturbed ionospheric conditions on October 13, 1961, with the same type of vehicle. "Spread F" returns were obtained during the first portion of the flight, in addition to the normal topside echoes. This paper presents the results of the rocket tests and reviews the overall NASA topside sounder satellite program. Author

**N63-13859** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

**A STUDY OF THE FREE OSCILLATIONS OF THE EARTH**

Gordon J. F. Mac Donald and Norman F. Ness Washington, NASA, 1962 49 p 53 refs
(NASA TR-R-136) GPO: $0.50

Published observations on the toroidal oscillations of the earth are critically reviewed. A supplementary analysis of the record obtained by the Lamont strain seismometer is presented. Eleven

toroidal modes are identified and it is concluded that the periods are known to within one percent. A perturbation scheme involving the ratio of the earth's angular velocity to the resonant frequency is used in calculating the effects on the resonant frequency due to the earth's rotation. The perturbations of the toroidal oscillations due to core-mantle interaction are treated in detail. Author

**N63-13926** Air Force Cambridge Research Labs. Geophysics Research Directorate, Bedford, Mass.

**RHODIUM-102 HIGH ALTITUDE TRACER EXPERIMENT I—STRATOSPHERIC RESULTS Research Report**

Marvin I. Kalkstein July 1962 56 p 28 refs

(AFCRL-62-460(1))

In order to have a unique tracer for the study of atmospheric circulation, a large amount of the rhodium-102 isotope was produced in a high altitude nuclear explosion at about 16° north latitude and 170° west longitude on 11 August 1958 at 2330 hours. The detonation took place at about 43 kilometers, and it is estimated that the bulk of the debris almost certainly rose to above 100 km and probably went at least as high as 150 km. Most of the results to be discussed are for air filter samples collected by aircraft at about 20 km in the stratosphere and about 5.5 km in the troposphere. It would appear that the bulk of the material went to fairly high altitude and then was distributed fairly evenly between the two hemispheres in the high stratosphere. Subsequent appearance in the low stratosphere seems to be mainly due to downward movement selectively in the region of the winter pole followed by circulation toward lower latitudes at the lower altitudes. Author

**N63-13932** Georgia Inst. of Tech. Engineering Experiment Station, Atlanta

**STUDY OF NATURAL ULTRAVIOLET BACKGROUNDS AT HIGH ALTITUDE Final Report, (July 1, 1961-November 30, 1962)**

H. D. Edwards, E. Rhodes, and D. Kurts Dec. 1962 36 p 9 refs

(Contract AF 19(604)-8840; ARPA Order-30)

(AFCRL-63-252)

The scanning photoelectric Ebert spectrometer designed by W. G. Fastie of Johns Hopkins University is being modified to study scattered sunlight in the 2000 to 4000 Å region. The instrument will be flown to the vicinity of 40 km by a balloon and held in position by a solar pointing control. The basic spectrometer has been tested at ground level in the visible region, and sample spectra of these tests are included. Three appendices are attached which cover specialized topics relating to some aspects of the spectrometer problem. Author

**N63-13953** Royal Aircraft Establishment, Farnborough (Gt. Brit.)

**THE EARTH AS AN ALTERNATING CURRENT CONDUCTOR (DIE ERDE ALS WECHSELSTROMLEITER)**

O. Mayr London, Ministry of Aviation, Dec. 1962 21 p 7 refs

Transl. by H. C. Ransom from Elektrotech. Z. (W. Berlin), no. 36, 1925, p 1352-1355 and no. 38, p 1436-1440

(RAE Library Translation 1023)

Taking into consideration the mutual electrodynamic effects of current in the ground and in conductors, the propagation of the earth's current along a long a.c. conductor was calculated with the earth as a return conductor. It was shown that the majority of the lines of current, independent of the conductor length, run within a distance of a few kilometers parallel to the conductor. The calculations yield new formulae for the specific and the mutual impedances of loops with the earth as return conductor. Author

**N63-13957** Air Force Cambridge Research Labs. Geophysics Research Directorate, Bedford, Mass.

**ATLAS OF MONTHLY MEAN STRATOSPHERE CHARTS, 1955-1959, PART II, JULY-DECEMBER**

H. Stuart Muench and Thomas R. Borden, Jr. Oct. 1962 99 p 14 refs

(Air Force Surveys in Geophysics-141; AFCRL-62-494(II))

Average conditions in the stratosphere over the northern hemisphere during the period July 1955 to July 1959 are depicted. Monthly mean charts of contours and isotherms are presented for the 100-mb, 50-mb, and 25-mb levels for each of the 48 months. In addition, four-year composite means are presented for each of the twelve months of the year at each level. The maps clearly show how the monthly mean pattern for a winter month can vary considerably from year to year, whereas the patterns for the summer months vary but little from year to year. Author

**N63-13959** Minnesota U. School of Physics, Minneapolis

**BALLOON FLIGHT RECORD STATUS REPORT AS OF 31 DECEMBER 1961**

John R. Winckler Feb. 1962 11 p

(Sponsored by NASA, NSF, and ONR)

OTS: $1.60 ph, $0.80 mf

The balloon flights conducted during 1961 to monitor the fluxes of charged particles in the atmosphere are tabulated. Flights carrying standard monitoring equipment (ion chambers, single geiger counters, nuclear emulsions and geiger telescopes) were conducted weekly from Minneapolis, Minn. In addition, flights carrying scintillation counters as well as geiger telescopes were conducted to measure X-rays resulting from precipitation of electrons on the atmosphere. Simultaneous launchings were conducted during the cosmic ray events and solar activity in July 1961. The flight number, launch time, launch location, duration, and type of monitoring equipment are tabulated for each flight. M.P.G.

**N63-13970** Iowa State U., Iowa City

**A NEW METHOD OF COMPUTING COSMIC-RAY CUTOFF RIGIDITY FOR SEVERAL GEOMAGNETIC FIELD MODELS**

Herbert H. Sauer Repr. from J. Geophys. Research, v. 68, no. 4, Feb. 15, 1963 p 957-971 14 refs

(NASA Grant NsG-233-62; Contract N9onr-93803)

An approximate method of computing cosmic-ray cutoff rigidities is presented. The geomagnetic field is represented by the combination of a sixth-order magnetic field whose origin lies entirely within the earth, and that due to a filamentary equatorial ring current of various radii and magnetic moments. The sixth-order spherical-harmonic expansion of the scalar magnetic potential is that obtained by Finch and Leaton by numerical analysis of surface magnetic field measurements for epoch 1955. Vertical cutoff rigidities have been computed for all IGY stations of geomagnetic latitude greater than ±45° listed in the *Annals of the International Geophysical Year*, vol. 8. In addition, the vertical cutoff rigidities have been calculated for geographic latitude steps of 5° in geographic longitude steps of 10° for the sixth-order field alone in regions of geomagnetic latitude greater than ±45°. The results are compared with the values given by Quenby and Webber, and by Quenby and Wenk, and with those derived from the magnetic shell parameter *L*. Comparisons of the values of vertical cutoff rigidity obtained for Port aux Francais, Northern Italy, and Minneapolis with those obtained by McCracken, Lynch, and Kellogg, respectively, by calculation of particle trajectories are consistent with the 5-percent precision claimed for the present method. Author

**N63-13990** RAND Corp., Santa Monica, Calif.

**MAGNETIC FIELDS OF THE EARTH AND PLANETS**

J. W. Kern and E. H. Vestine Mar. 1963 66 p 143 refs Submitted for Publication

(NASA Contract NASr-21(05))

(RM-3523-NASA) OTS: $6.60 ph, $2.18 mf

Knowledge of geomagnetism and its effects was recently much augmented during the IGY. This knowledge not only suggests that much may be learned of our neighbors in space by making an early determination of their magnetic fields, but also provides a foundation for many inferences and rough estimates on the magnetic fields of other solar-system bodies. Present estimates range from 660 c.g.s. for Jupiter to 0.004 for the smaller satellites and the planetoids. Author

**N63-14004** Air Force Cambridge Research Labs. Geophysics Research Directorate, Bedford, Mass.

**DENSITY DISTRIBUTION, INTERLEVEL CORRELATIONS AND VARIATION WITH WIND**

Allen E. Cole and Arnold Court July 1962 124 p 158 refs
(AF Surveys in Geophysics-151; AFCRL-62-815)

Geographical, seasonal, and day-to-day variations in the vertical distribution of atmospheric density for altitudes up to 30 km are analyzed. Variability is least at 7 to 8 km, the isopycnic level, where densities do not depart from the standard by more than 1 or 2 percent in any season or area. Between 24 and 26 km, density changes little with latitude but markedly with season. At the level of greatest seasonal variability, around 15 km, the relative departures from standard of mean seasonal densities is strictly according to latitude. Largest negative departures occur at the northernmost location; largest positive, at the southernmost. The greatest difference between the two extreme profiles, nearly 20 percent, occurs in winter. The largest day-to-day variations around monthly means occur near the tropopause. Coefficients of variation range from approximately 2 percent at Tampa in the summer to 6 percent at St. Paul Island in the winter. Author

**N63-14012** National Aeronautics and Space Adminstration, Washington, D.C.

**INTERNATIONAL GEOPHYSICAL YEAR BIBLIOGRAPHY OF LITERATURE PUBLISHED IN RUSSIAN IN 1960**

R. F. Zatrutina and L. S. Rubina Mar. 1963 195 p 1172 refs
Transl. of the book "Mezhdunarodnyy geofizicheskiy god. Bibliograficheskiy ukazatel' literatury na russkom yazyke za 1960 g.", 4th ed. Moscow, Acad of Sci., 1961
(NASA TT F-109) OTS: $3.00

This bibliography contains about 1,200 references to publications issued in 1960. All nongeophysical data are excluded; it contains only material based on observations and experiments carried out as part of the IGY program, including the International Geophysical Cooperation period (1959). Author

**N63-14027** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

**ELECTRON DENSITY DISTRIBUTION IN THE UPPER F-REGION**

S. Chandra Washington, NASA, Mar. 1963 12 p 16 refs
(NASA TN D-1751) OTS: $0.50

A modified Chapman function with a variable scale height gradient has been found to be in good agreement with the electron-density distribution obtained experimentally within the height range of about 100 km below the $F_2$ peak to an altitude of about 700 km. The scale height distribution derived from this model is also consistent with the neutral-gas scale height of the 1961 COSPAR International Reference Atmosphere. Author

**N63-14035** Geophysics Corp. of America, Bedford, Mass.

**STUDY OF PERTURBATIONS IN IMPORTANT UPPER ATMOSPHERIC CHEMICAL SYSTEMS Scientific Report No. 4**

S. Millman, W. Tank, and J. Pressman Dec. 1962 56 p 37 refs
(ARPA Contract SD-112; ARPA Order 286-62)
(GCA Tech. Rept. 62-5-G)

This report is one in a series attempting to evaluate the long-range effects of rocket pollution on the upper atmosphere. Author

**N63-14036** Geophysics Corp. of America, Bedford, Mass.

**SUMMARY OF ULTRAVIOLET MISSILE EXHAUST GAS INTERACTIONS Scientific Report No. 5**

W. Reidy Dec. 1962 83 p 28 refs
(ARPA Contract SD-112; ARPA Order 286-62)
(GCA-TR-62-6-G)

The problems related to the interaction of the solar UV with rocket exhaust gases are covered as follows: solar spectrum; effect of line absorption; UV absorption by ionization or dissociation; selected absorption spectra; and ionospheric effects due to UV absorption. R.C.M.

**N63-14037** Geophysics Corp. of America, Bedford, Mass.

**MODIFICATION OF UPPER ATMOSPHERIC TEMPERATURE STRUCTURE BY ROCKET POLLUTION Scientific Report No. 8**

J. Connell and J. Pressman Dec. 1962 87 p 16 refs
(ARPA Contract SD-112; ARPA Order 286-62)
(GCA-TR-62-13-G)

Changes in the temperature structure of the upper atmosphere are studied to determine the order of magnitude of temperature changes which might cause dynamic motion. This report estimates the change in temperature at a height range from 30 km to 150 km, due to placing a horizontal layer of any of the five gases CO, NO, $H_2O$, $CO_2$, or OH into the atmosphere. The layer is always assumed to have a density $N = 10^{10}$ molecules/cc and to be 10 km thick. Temperature changes at other concentrations and layer thicknesses can also be estimated. A.R.B.

**N63-14038** Geophysics Corp. of America, Bedford, Mass.

**OZONOSPHERIC MODIFICATION BY MISSILE EXHAUST Scientific Report No. 9**

S. Millman, J. Pressman, and P. Warneck Dec. 1962 66 p 24 refs
(ARPA Contract SD-112; ARPA Order 286-62)
(GCA-TR-62-14-G)

The possible changes in the ozonosphere (15 km to 30 km) are considered as a result of rocket-exhaust pollution. The areas covered include: normal ozonospheric relaxation times and optical properties; reactions resulting in a decrease or increase of ozone; and ozone luminescence. It is tentatively concluded that, under the proper conditions, ozone could be locally consumed. R.C.M.

**N63-14039** Geophysics Corp. of America, Bedford, Mass.

**IONOSPHERIC MODIFICATION OF MISSILE EXHAUST Scientific Report No. 10**

A. Dalgarno Dec. 1962 16 p
(ARPA Contract SD-112; ARPA Order 286-62)
(GCA-TR-62-15-G)

Changes in the high F region, and the D, E, and F regions of the ionosphere, which may be created by the introduction of rocket-exhaust contamination, are evaluated as to the kind of changes and the orders of magnitude. Secondary effects and collision frequency resulting from contamination are discussed. A.R.B.

**N63-14046** Michigan U., Ann Arbor

**THE DISSOCIATION OF OXYGEN MEASURED BY A ROCKET-BORNE MASS SPECTROMETER**

Edward J. Schaefer [1963] Repr. from J. Geophys. Research, v. 68, no. 4 Feb. 15, 1963 p 1175-1176 5 refs
(NASA Contract NASw-138)

Instrumentation designed to measure the ambient neutral composition of the upper atmosphere was flown aboard a Nike-Cajun rocket launched in May 1962, at Wallops Island, Virginia. The major differences between this experiment and those conducted in the past were: (1) The analyzing instrument was the massenfilter instead of the Bennett mass spectrometer. (2) The entire instrumentation was ejected from a pressurized helium enclosure, which enclosure minimized the effects of rocket-borne contaminants. (3) The ion source

was designed for direct immersion in the ambient atmosphere with the greatest open look angle that could be practically achieved. The purpose of this design was to minimize the probability of surface recombination of the active constituents such as atomic oxygen.

The payload achieved a peak altitude of 134.5 km. Spectra were obtained between 95 km and the peak on both the upleg and downleg parts of the trajectory. Spectral peaks at atomic mass number 14, 16, 18, 32, 40, and 44 were detected. The most probable chemical identification of these mass numbers in the order given are N, O, $H_2O$, $N_2$, $O_2Ar$, and $CO_2$ (and $N_2O$). Data analysis has progressed to the point of plotting telemetered atomic and molecular ion currents as functions of altitude. I.v.L.

**N63-14077** Pennsylvania State U. Ionosphere Research Lab., University Park

**THE EFFECT OF DIFFUSION ON THE EQUILIBRIUM ELECTRON DENSITY DISTRIBUTION IN THE F REGION NEAR THE MAGNETIC EQUATOR**

Richard A. Goldberg May 1, 1962 82 p 61 refs
(NSF Grant G-22040)
(Sci. Rept. 184)

On the basis that electrons are constrained to move along the lines-of-force of the earth's magnetic field, and that the primary forces acting are due to gravity and pressure gradients, a two-dimensional partial differential equation is derived for the equilibrium electron-density distribution around the magnetic equator in an isothermal F region. A solution is developed in the form of a power series in magnetic latitude. By using a Chapman-like profile at the equator as a boundary condition, it is shown that the solution exhibits the major features of the well-known geomagnetic anomaly as observed at the equinoxes. The solution also predicts the electron density distribution above the F2 electron peak, where there are presently no observations as a function of magnetic latitude. The effect of varying sunspot number is examined. Author

**N63-14081** California U., Berkeley. Lawrence Radiation Lab.

**EAST-WEST ASYMMETRY IN THE FLUX OF MIRRORING GEOMAGNETICALLY TRAPPED PROTONS**

Harry H. Heckman and George H. Nakano Dec. 13, 1962 18 p 10 refs
(Contract W-7405-eng-48)
(UCRL-10587) OTS: $0.50

The visual detection of geomagnetically trapped protons in the region of the South Atlantic magnetic anomaly is reported. Protons of energy $\geq 57$ Mev were recorded in nuclear emulsions during a 65-orbit, oriented flight of a satellite recovered on September 1, 1962. An east-west asymmetry in the flux of geomagnetically trapped protons was observed, confirming an effect predicted by Lenchek and Singer. From measurements of the east-west asymmetry, a value of $62.0 \pm 5.0$ km was obtained for the scale height of the atmosphere at 364-km altitude. Author

**N63-14092** London U. Queen Mary Coll. (Gt. Brit.)

**GEOMAGNETIC CONTROL OF DIFFUSION IN THE $F_2$ REGION OF THE IONOSPHERE 2—NUMERICAL RESULTS Technical Note**

P. C. Kendall (Bedford Coll. and High Altitude Observatory, Boulder, Colo.) Oct. 25, 1962 12 p 23 refs
(Contract AF-EOARDC-61-41)
(AFCRL-62-229)

The equation governing electron diffusion in the $F_2$ region along the lines-of-force of a geocentric magnetic dipole, whose axis coincides with the earth's, is solved numerically in the equilibrium case when there is electron production, loss by recombination, but no transport of electrons by electrodynamic drift. The results show that for the parameter values considered, the extra terms in the diffusion equation, caused by the variation of the gravity component along a line-of-force, lead to only a slight dip in $N_{max}$ at the equator. The dip is much too small to explain the Appleton anomaly in terms of diffusion alone. Author

**N63-14173** Alaska U. Geophysical Inst., College

**EARTH CURRENTS AT THE AURORAL ZONE Final Report**

V. P. Hessler and R. R. Heacock Dec. 1962 59 p 89 refs
(Contract AF 19(604)-3075)
(UAG-R133; AFCRL-63-207)

The research program on earth currents is summarized and covers: a review of literature on the currents; a discussion of recording equipment including electrodes and electrode spacing, a control panel for recording earth currents, an X-Y plotter, cycle counting equipment, portable earth current recording equipment, an electron beam magnetometer, micropulsation recording equipment, and recording procedures; a summary of experimental results and analysis including amplitude activity, effect of topography and geology, comparison of earth current and magnetic traces, and earth current fluctuation counting. A.R.B.

**N63-14174** Pennsylvania State U. Ionosphere Research Lab., University Park

**THE COMPOSITION AND STRUCTURE OF THE TERRESTRIAL ATMOSPHERE**

Marcel Nicolet May 15, 1963 63 p 32 refs Presented at the AFOSR-GE Symp. on Dynamics of Manned Lifting Planetary Entry, Philadelphia, Oct. 29-31, 1962
(Contract AF 19(604)-4563; NSF Grant G-18983)
Sci. Rept. 185; AFCRL-63-289)

After a general description of the various regions of the terrestrial atmosphere, an analysis of physical conditions leading to the knowledge of the heterosphere is given. Molecular dissociation and diffusion in the lower thermosphere are introduced to determine the concentration of various constituents ($N_2$, $O_2$, O, N, He, H). Ultraviolet heating and conduction are considered as essential processes of production and loss of heat in the thermosphere. The ionospheric diffusion equilibrium is studied after considering the system of ionic reactions occurring in the ionosphere. Author

**N63-14180** Air Force Cambridge Research Labs. Geophysics Research Directorate, Bedford, Mass.

**RESULTS FROM AN ARTIFICIAL IRON METEOROID AT 10 KM/SEC**

Richard E. Mc Crosky (Harvard Coll. Obs.) and Robert K. Soberman July 1962 24 p 15 refs
(AFCRL-62-803)

A type 304 stainless steel pellet of approximately 2.2-gm mass was propelled downward into the atmosphere from an altitude of about 190 km to produce an artificial meteor. The pellet was observed, visually and photographically, moving with an initial velocity of approximately 10 km/sec. The photographs were reduced by the standard precision method normally used for meteors. A value of approximately $8 \times 10^{-19}$ (cgs and $M_{pg}$) is obtained for the luminosity coefficient $\tau_o$ of the pellet. Various corrections needed to convert this value to a luminosity coefficient valid for meteoric material are discussed. Author

**N63-14182** Air Force Cambridge Research Labs. Geophysics Research Directorate, Bedford, Mass.

**OBSERVATIONS OF THE DIURNAL VARIATION OF 5577 A[OI] AT SACRAMENTO PEAK, NEW MEXICO AND NATICK, MASSACHUSETTS Research Note**

H. E. Cronin (Northeastern U.) and S. M. Silverman Oct. 1962 10 p 6 refs
(AFCRL-62-1024)

Observations of the diurnal variation of 5577 A[OI] for the same night for four nights in September 1961, at Sacramento Peak, New Mexico, and Natick, Massachusetts, were compared. The product moment correlation coefficient for the intensities at the same local mean times was zero, showing that no correlation existed. Correlation coefficients were then calculated using hourly and daily values for Sacramento Peak with Fritz Peak, Colorado; Rapid City, South Dakota; and Haute Provence, France; using IGY-IGC data. These were found to be significant at better than the 5-percent significance level except for the Sacramento Peak—Haute Provence daily correlation. The reason for the discrepancy between this correlation and that for Sacramento Peak-Natick is not known at this time. Author

# 13 HEAT TRANSFER

Includes: ablation; cooling; heating; and other thermal effects.

*For aerothermodynamics see:* 02 Aerodynamics of Bodies, Combinations, and Internal Flow; and 03 Aerodynamics of Wings and Control Surfaces.

*For combustion see:* 26 Propellants and Combustion.

*For related information see:* 11 Fluid Mechanics.

**N63-13874** National Advisory Committee for Aeronautics. Langley Aeronautical Lab., Langley Field, Va.

**HEAT-TRANSFER MEASUREMENTS IN FREE FLIGHT AT MACH NUMBERS UP TO 14.6 ON A FLAT-FACED CONICAL NOSE WITH A TOTAL ANGLE OF 29°**

Charles B. Rumsey and Dorothy B. Lee Washington, NACA, Jan. 24, 1958 44 p 9 refs
(NACA RM L57L03) OTS: $4.60 ph, $1.25 mf (Declassified)

Skin-temperature measurements have been made at several locations on a flat-faced cone-cylinder nose which was flight tested on a five-stage rocket-propeller model to a Mach number of 14.64 and a free-stream Reynolds number of $2.0 \times 10^6$, based on flat-face diameter, at an altitude of 66,300 feet. The copper nose had a 29° total-angle conical section which was 1.6 flat-face diameters long. The aerodynamic-heating rates determined from the temperature measurements reached 1,440 Btu/(sec) (sq ft) on the flat face. The heating rates near the center of the flat face agreed well at Mach numbers up to 13.6 with those obtained by a theory for laminar stagnation-point heating in equilibrium dissociated air (AVCO Res. Rep. 1). At Mach numbers above 13.6, the heating rates at locations near the center of the flat face became progressively lower than stagnation-point theory and were 29 percent lower at Mach number 14.6 at the end of the test. The reason for this behavior of the heating on the central part of the flat face was not determined. Excluding the relatively low heating rates that occurred on the central part of the nose at the highest Mach numbers, the distribution of experimental heating along the innermost 0.79 of the flat-face radius, expressed as a percentage of stagnation-point heating, was in fair agreement with the distribution predicted by laminar theory. At a location of 0.71 radii from the stgnation point, the experimental heating was very near 130 percent of the theoretical stagnation-point rate at Mach numbers from 11 to 14.5. The experimental heating rates on the conical section of the nose were in good agreement with laminar-cone theory using the assumption of theoretical sharp-cone static pressure on the conical section. Author

**N63-13875** National Advisory Committee for Aeronautics. Langley Aeronautical Lab., Langley Field, Va.

**FREE-FLIGHT AERODYNAMIC-HEATING DATA AT MACH NUMBERS UP TO 10.9 ON A FLAT-FACED CYLINDER**

William M. Bland, Jr., Andrew G. Swanson, and Ronald Kolenkiewicz Washington, NACA, Jan. 13, 1958 48 p 17 refs
(NACA RM L57K29) OTS: $4.60 ph, $1.64 mf (Declassified)

A five-stage rocket-propelled model has been flown up to a Mach number of 10.9 and a corresponding free-stream Reynolds number of $6.57 \times 10^6$, based upon nose diameter. Maximum Mach number was attained at an altitude of 49,300 feet as the model flew along a reentry-type trajectory at nearly zero angle of attack. Temperatures were measured at 16 stations on the inside of a flat-faced cylinder made of copper. Maximum temperatures of 1,085° F and 820° F were measured inside the flat face and the cylindrical sides, respectively, at the end of the test. Aerodynamic-heating rates, derived from the temperature measurements and corrected for conduction effects, reached a maximum value of about 495 Btu/(sec) (sq ft) on the flat face (near the corner) and less than 170 Btu/(sec) (sq ft) on the cylindrical sides. Experimental aerodynamic-heating rates near the center of the flat face, though generally lower, varied about the same as that predicted by a theory for equilibrium-dissociated laminar flow as the Mach number increased. The experimental heating rates increased as the corner was approached with the rate at the temperature-measuring station nearest the corner for which heat-transfer data could be obtained being almost 1½ times the rate near the center of the flat face. On the cylindrical sides of the nose, well downstream of the corner, the heating rates were low and appeared to agree fairly well with theoretical values for laminar flow. Author

**N63-13877** National Advisory Committee for Aeronautics. Ames Aeronautical Lab., Moffett Field, Calif.

**AN ANALOG STUDY OF THE INFLUENCE OF INTERNAL MODIFICATIONS TO A WING LEADING EDGE ON ITS TRANSIENT TEMPERATURE RISE DURING HIGH-SPEED FLIGHT**

Carr B. Neel Washington, NACA, Mar. 17, 1958 50 p 6 refs
(NACA RM A57K21) OTS: $4.60 ph, $1.70 mf (Declassified)

An investigation was made with an electrical heat-flow analog to determine the effect of internal modifications to a wing leading edge on the surface-temperature rise and temperature distribution for conditions of transient aerodynamic heating at high supersonic speeds. The study showed that when heat-absorbing material is concentrated in the wing leading-edge region, in the case of wings of large leading-edge radius, the temperature rise at the leading-edge point is determined primarily by the specific heat of the material. As the leading-edge radius is decreased, the thermal conductivity of the heat-absorbing material was shown to have an increasingly important effect. For cases of wings in which the skin is of uniform thickness in the leading-edge region, thermal conduction is of major importance in restricting the leading-edge temperature rise. Because of its high specific heat and thermal conductivity, beryllium appears attractive in heat-sink applications. In an example, beryllium was shown to be far superior to Inconel-X from the standpoints of leading-edge-temperature rise, temperature distribution, and weight. Author

**N63-13890** National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.

**FREE-FLIGHT HEAT-TRANSFER INVESTIGATION AT SUPERSONIC SPEEDS OF TWO SLENDER CONE-CYLINDER BODIES AT AN ANGLE OF ATTACK OF 8° WITH ONE BODY ROTATING**

Ralph A. Falanga Washington, NASA, Jan. 1959 43 p 7 refs
(NASA MEMO 12-31-58L) OTS: $4.60 ph, $1.49 mf (Declassified)

In a free-flight investigation, wall temperatures were measured on two slender cone-cylinder bodies at an angle of attack of 8° with one body rotating between 4 to 5 revolutions per second. The free-stream Mach number range was from 2.5 to 4.5 and free-stream Reynolds number per foot ranged from $13.5 \times 10^6$ to $19.6 \times 10^6$. The wall temperatures on the rotating body measured at a station 62.8 percent of the body length were approximately equal to the mean circumferential temperature on the fixed body for the range of free-stream Mach numbers investigated. Along the windward

meridian line of the fixed body, the Stanton number showed that the boundary layer was laminar up to 62.8 percent of the body length and up to a free-stream Mach number of 3.5. At Mach numbers above 3.5, the transition point moved forward of this station. The highest heat-transfer rates on the conical section of the fixed body occurred between circumferential angles of 45° and 56°. The magnitudes of the heat-transfer coefficients along the windward meridian line of the rotating body were between 0.03 to 0.04 for most of the measuring stations and through most of the Mach number range. The experimental pressure coefficients measured on the conical surface of the fixed body agreed with the trend computed from potential-flow theory. Author

**N63-13950** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

**EXPERIMENTAL PRESSURES AND TURBULENT HEAT-TRANSFER COEFFICIENTS ASSOCIATED WITH SINUSOIDAL PROTUBERANCES ON A FLAT PLATE AT A MACH NUMBER OF 3**

Charles P. Shore, Sidney C. Dixon, and George E. Griffith Washington, NASA, Mar. 1963 29 p 7 refs
(NASA TN D-1626) OTS: $0.75

An exploratory investigation was made to determine the local effects on aerodynamic heating produced by three-dimensional sinusoidal-type skin buckles of various depths. Tests were made at a Mach number of 3.0, a stagnation pressure of 200 pounds per square inch absolute, a stagnation temperature of 500° F, and a free-stream Reynolds number per foot of approximately $14 \times 10^6$. Temperatures were obtained from one set of test specimens, pressures from another. The test results, presented in terms of Stanton numbers and pressure coefficients, show that marked increases or decreases in aerodynamic heating and pressure can result from changes in contour produced by skin buckles. Author

**N63-13965** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

**SUBCOOLED BOILING HEAT TRANSFER UNDER FORCED CONVECTION IN A HEATED TUBE**

S. Stephen Papell Washington, NASA, Mar. 1963 23 p 14 refs
(NASA-TN D-1583) OTS: $0.75

Single- and two-phase heat-transfer data were obtained by using distilled water flowing through an Inconel X resistance-heated tube. The nonboiling data were correlated with a Colburn-type equation that was modified to include the boiling phenomena by means of three significant parameters obtained by dimensional analysis from basic considerations. Comparable heat-transfer data from reference sources, covering a broad range of conditions, were used in the development of the correlation. The reference data and the limited data obtained from the experimental program extended the generality of the correlation to cover a range of pressure from 16 to 2000 pounds per square inch, heat flux from 0.026 to 56.0 Btu per square inch per second, fluid velocity from 1.33 to 204 feet per second, and subcooling from 6° to 336° F. Liquid-ammonia data were included to demonstrate the applicability of the correlation to fluids other than water. Comparisons were made between wall temperatures at the incipience of boiling as predicted by an analytically derived equation and the experimental data. Author

**N63-13968** Aeronautical Research Council (Gt. Brit.)

**HEAT TRANSFER THROUGH A CONSTANT-PROPERTY LAMINAR BOUNDARY LAYER PART I. CALCULATIONS BASED ON STRATFORD'S METHOD**

N. Curle (NPL) London, HMSO, 1962 23 p 6 refs
(ARC-R&M-3300; previously issued as ARC-22584 and ARC-22583) Available from HMSO: 9s. 6d.

The heat transfer through a constant-property laminar boundary layer is calculated by the methods of Lighthill and Stratford. In the first case, empirical fitting ensures good agreement with similar solutions, and application to flow past circular cylinder yields good agreement with experiment. In the second case, the solutions are valid for the inner and outer parts of the boundary layer. Author

**N63-14076** Argonne National Lab., Ill.

**THE AXISYMMETRIC FREE-CONVECTION HEAT TRANSFER ALONG A VERTICAL THIN CYLINDER WITH CONSTANT SURFACE TEMPERATURE**

R. Viskanta Jan. 1963 28 p 15 refs
(Contract W-31-109-eng-38)
(ANL-6660)

The subject of this study is the problem of laminar free-convection flow produced by a heated, vertical, circular cylinder for which the temperature at the outer surface of the cylinder is assumed to be uniform is studied. The soution of the boundary-layer equations was obtained by two methods: (1) the perturbation method of Sparrow and Gregg, which is valid only for small values of the axial distance parameter $\xi$ and (2) the integral method of Hama *et al.*, for large values of the parameter $\xi$. Heat-transfer results were calculated for Prandtl numbers (Pr) of 100, 10, 2, 1, 0.72, 0.1, 0.03, 0.02, and 0.01. It was found that the Nusselt numbers (Nu) for the cylinder were higher than those for the flat plate, and this difference increased as Pr decreased. It was also found that the perturbation method of solution of the free-convection boundary-layer equations becomes useless for small values of Pr because of the slow convergence of the series. The results obtained by the integral method were in good agreement with those calculated by the perturbation method for $Pr \approx 1$ and $0.1 < \xi < 1$ only; they deviated considerably for smaller values of $\xi$. Author

**N63-14214** Massachusetts Inst. of Tech. Div. of Sponsored Research, Cambridge

**THE MECHANISM OF HEAT TRANSFER IN NUCLEATE POOL BOILING**

Chi-Yeh Han and Peter Griffith Mar. 30, 1962 82 p 18 refs
(Contract Nonr-1841(39))
(Rept. 7673-19)

A criterion is developed for bubble initiation from a gas-filled cavity on a surface in contact with a superheated layer of liquid. It is found that the temperature of bubble initiation on a given surface is a function of the temperature conditions in the liquid surrounding the cavity as well as the surface properties themselves. It is also found that the delay time between bubbles is a function of the bulk liquid temperature and the wall superheat and is not constant for a given surface. The initiation, growth, and departure criterions are each experimentally, individually checked. They are then used to compute the heat transfer near the knee of the boiling curve, using only an experimental determination of the number of bubbles as a function of wall superheat and other known quantities. Author

## 14 HUMAN BEHAVIOR

Includes: crew training and evaluation; piloting; psychological factors.

*For simulators see:* 10 Facilities.

*For related information see:* 16 Life Sciences.

**N63-13790** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

**PILOT-CONTROLLED SIMULATION OF RENDEZVOUS BETWEEN A SPACECRAFT AND A COMMANDED MODULE HAVING LOW THRUST**

Gary P. Beasley Washington, NASA, Mar. 1963 17 p 4 refs
(NASA TN D-1613) OTS: $0.50

A pilot's ability to control remotely the terminal phase of rendezvous between his orbiting spacecraft and an approaching commanded module which had relatively low thrust was studied by using a six-degree-of-freedom simulation. In this study, fixed-thrust engines were used and operated in an on-off manner. The thrust levels were adjusted to provide the commanded module with initial acceleration capabilities of 0.02g and 0.03g. For the initial rendezvous conditions assumed, these thrust accelerations were less than three times the sum of the apparent gravity differences between the vehicles and the maximum difference in centrifugal force. Results of this simulation study indicate that a human pilot, given visual information, range, and range rate, can control a low-thrust vehicle to effect terminal rendezvous under a variety of initial conditions. Author

**N63-14044** Aerospace Medical Div., Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio

**PRELIMINARY COST COMPARISON OF TECHNICAL TRAINING BY CONVENTIONAL AND PROGRAMMED LEARNING METHODS [Final Report]**

Felix F. Kopstein and Richard T. Cave July 1962 24 p 3 refs
(AMRL-TDR-62-79) OTS: $0.75

This report considers the comparative costs of training airmen, with automated and conventional instruction, for electronics specialities. Three different methods of estimating the costs of the prototype automated course are compared with the estimated costs of the current conventional course. Costs of automated instruction compare favorably with those of the conventional course regardless of the method of estimation. These programing costs continue to diminish as the number of students trained increases, whereas conventional costs remain constant. Generalizations related to the economic factors of auto-instruction are discussed in terms of general application to Air Force training courses. Author

# 15 INSTRUMENTATION

Includes: design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gauges; and sensors and transducers.

*For related information see:* 06 Auxiliary Systems; 08 Communications; 09 Electronics; and 22 Navigation and Guidance.

**N63-13795** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

**A DETECTOR FOR LOW ENERGY GAMMA-RAY ASTRONOMY EXPERIMENTS**

K. J. Frost and E. D. Rothe Washington, NASA, Mar. 1963 10 p 12 refs
(NASA TN D-1693) OTS: $0.50

A detector has been developed specifically for rocket- and satellite-borne low-energy gamma-ray astronomy experiments. This detector consists of a CsI(Tl) crystal, 2 inches long by 1 inch in diameter, viewed by a single photomultiplier tube together with a CsI(Tl) crystal, 8.75 inches long by 5.75 inches in diameter, viewed by four photomultiplier tubes. The small crystal is inserted into a well of the larger crystal, their two outputs being run in anticoincidence. The output from the small crystal surviving the anticoincidence circuit is fed into a pulse-height analyzer. This detector and its mode of operation provide a gamma-ray spectrometer that has angular collimation, low background sensitivity, suppression of the Compton continuum, and relatively high photopeak efficiency. Data on the photopeak efficiency, angular response, and suppression of the Compton continuum at various energies are presented. Reasons for using anticoincidence shielding to contend with background problems, rather than bulk shielding with lead, are discussed. Author

**N63-13801** Air Force Cambridge Research Labs. Geophysics Research Directorate, Bedford, Mass.

**PROPORTIONAL COUNTER SPECTROMETER FOR SOLAR X RAYS BETWEEN 1 AND 10 ANGSTROMS**

Roger Smith (Adcole Corp.), Leon Heroux, and James E. Manson Dec. 1962 26 p 19 refs
(AFCRL-62-1105; *Its* Instrumentation for Geophysics and Astrophysics No. 23)

The construction and operation of a proportional-counter spectrometer for measurements of solar X-rays are described. The spectrometer was designed so that the detector and its associated circuitry could be mounted as auxiliary equipment on a telemetering monochromator that is flown in an Aerobee Hi rocket and pointed at the sun. The spectrometer analyzes solar radiation in five intervals of wavelength between about 0.8 and 10 angstroms. Author

**N63-13804** Aeronautical Research Council (Gt. Brit.)

**THE CALIBRATION OF A 60° CONE TO MEASURE MACH NUMBER, TOTAL PRESSURE AND FLOW ANGLES AT SUPERSONIC SPEEDS**

D. R. Andrews and W. G. Sawyer London, HMSO, 1963 29 p 5 refs
(ARC CP-628; previously issued as ARC-24106) Available from HMSO: 4s. 6d.

The characteristics of a 60°-apex-angle cone for measuring local Mach number, total pressure, and flow directions have been determined at Mach numbers of 2.47, 3.25, 3.97 and 4.32 at angles-of-pitch up to 29°. Author

**N63-14009** Arizona U. Lunar and Planetary Lab., Tucson

**A COMPLETELY DIGITIZED MULTI-COLOR PHOTOMETER**

H. L. Johnson and R. I. Mitchell *In its* Communications of the Lunar and Planetary Laboratory, Vol. I No. 14, June 28, 1962 p 73-81
15 refs (See N63-14008 09-05) OTS: $5.60 ph, $1.91 mf

A completely digitized multicolor photometer has been built at the University of Texas and the University of Arizona. This device, which makes photometric observations in nine wavelength bands ranging from 0.35 to 5$\mu$, records on a punched paper tape all of the data that are necessary for the complete reduction procedure. A complete reduction program suitable for electronic computers such as the CDC 1604 or the IBM 7090 has been written and used for the reduction of more than 3000 observations taken with the photometer. A description of the photometer and the reduction program is given in this paper. Author

**N63-14011** Arizona U. Lunar and Planetary Lab., Tucson

**AN INFRARED STELLAR SPECTROMETER**

Gerard P. Kuiper, R. Goranson, A. Binder, and H. L. Johnson *In its* Communications of the Lunar and Planetary Laboratory, Vol. I No. 16, Nov. 6, 1962 p 119-127 6 refs (See N63-14008 09-05)
OTS: $5.60 ph, $1.91 mf

A grating spectrometer has been built for infrared observation of the stars and planets. The photoconductive detectors (PbS) are cooled with dry ice and the resolution is about 3Å for a detector width of 0.1 mm. With a 600-line-per-mm grating, the linear dispersion is of the order of $1Å = 0.00006\ f$ and if $f = 60$ cm, 1Å in the spectrum measures 0.036 mm. Diagrams are given of the spectrometer and of the preamplifier and amplifier circuits. R.C.M.

**N63-14026** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

**PERFORMANCE OF ELECTRICAL-RESISTANCE STRAIN GAGES AT CRYOGENIC TEMPERATURES**

Albert Kaufman Washington, NASA, Mar. 1963 22 p 3 refs (NASA TN D-1663) OTS: $0.75

Six types of commercial foil strain gages were investigated to determine whether they could be used in experimental stress analyses of space-vehicle structures at cryogenic temperatures. The effects of low temperatures on the gage factors were studied by mounting gages on constant-strain beams and loading them to strains of up to ±2000 microinches per inch with a strain-gage calibrator immersed in a cryogenic bath. These tests were conducted at room temperature and liquid-nitrogen (139° R) and liquid-hydrogen (36° R) temperatures. Hysteresis, creep, zero-drift effects, and linearity of the data were also studied in these tests. The more promising types of strain gages, as determined from the calibrator tests, were mounted on beta titanium tensile specimens and tested to higher strains of from 7500 to 13,000 microinches per inch in liquid hydrogen. Resistance measurements were made on the different gages at room temperature and dry-ice (350° R), liquid-nitrogen, liquid-hydrogen, and liquid-helium (7° R) temperatures. Author

**N63-14110** Mitsubishi Electric Mfg. Co., Ltd. Research Lab., Amagasaki (Japan)

**NEUTRON AND GAMMA-RAY DISCRIMINATION IN ORGANIC SCINTILLATORS**

Osamu Tanaka *In its* Mitsubishi Denki Laboratory Reports, Vol. 4, No. 1 Jan. 1963 p 101-115 12 refs (See N63-14104 09-01)

The neutron and gamma-ray discrimination for different scintillators and photomultipliers was observed using the space-charge effect in the photomultiplier. The space-charge effect in the photomultiplier and the fluctuation of the space-charge saturated pulse height are discussed. The efficiency of the neutron detector was about 10 percent at a neutron energy of 3.65 Mev using the JAERI 2-Mev Van de Graaff accelerator, while the gamma detection efficiency was negligibly small. The minimum energy of the detectable neutron was confirmed about 0.5 Mev. As an application of the detector, the neutron total cross sections of light nuclei were measured by the transmission method. Author

**N63-14192** Air Force Cambridge Research Labs. Geophysics Research Directorate, Bedford, Mass.

**WIND MEASURING SET AN/GMQ-20(v) SYSTEM EVALUATION**

Russell M. Pierce, Jr. Dec. 1962 36 p
(AFCRL-62-1110)

This report discusses the results of tests performed at AFCRL to determine the operation and accuracy of the individual components of the Wind Measuring Set AN/GMQ-20(v), when interconnected in any combination up to ten transmitters and eight indicators and/or recorders, and operated as a complete system under simulated field conditions. The evaluation of 50/60-cycle transmitter and receiver synchros for use in the applicable components of the set is also included. A list of the tests performed during the evaluation of both the system and the synchros is given, and includes test results and recommendations. The tests indicated that these synchros and all of the set components, excluding the Recorder RO-141/GMQ-20, are reliable and accurate. Author

**N63-14206** General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.

**N-CORE POWER MONITORING OF NUCLEAR REACTORS**

R. A. Du Bridge AEC Div. of Tech. Inform., Apr. 15, 1962 126 p 33 refs
(Contract AT(04-3)-189)
(GEAP-3914) OTS: $2.50

It is the conclusion of this study that both gamma and neutron flux can be used as parameters of power for power monitoring purposes. Gamma has the advantage of the availability of drift-free detectors, while neutrons have the advantage of fast response to power changes. The problems of fuel isotopic changes, nonuniform moderators, and averaging ability of power parameters are discussed. Several problems of ion chambers have been analyzed. The gas migration problem was eliminated by sealing off the ion chamber from its cable. Fission gas buildup in the chamber was shown analytically to cause no problem. Leakage current was shown to be small in comparison to ionization current in fluxes of $10^{14}$ nv up to 1000° F. Heating-type detectors have also been analyzed. The general heat-transfer equations for cylindrical geometry have been derived, and it has been shown that heating-type detectors are feasible, by choice of materials whose thermal conductivities are constant with respect to temperature and neutron exposure when placed in suitable convective heat-transfer environments. Many detectors have been constructed and temperature-tested. Author

**N63-14211** Dresser Industries, Inc. Dresser Research, Tulsa, Okla.

**A SEDIMENT DENSITY METER**

R. A. Hodgson, C. G. Denny and Ralph Monaghan Nov. 1962 30 p
(Contract AT(40-1)-2969)
(TID-18124)

A sediment density meter, using scattered gamma rays, was designed to facilitate the measurement of sedimentation on the bottom of oceans, lakes, and rivers. A laboratory prototype was subjected to mechanical and nuclear tests. The mechanical test performed on the instrument showed that sediment layers of at least 4.02 inches in thickness can probably be measured. The nuclear test proved the efficacy of measuring density in the range from 1.2 g/cm$^{-3}$ to 1.5 g/cm$^{-3}$ by counting the gamma ray backscatter. A.R.B.

# 16 LIFE SCIENCES

Includes: biology; exobiology; physiology; medicine; life support systems; radiation effects on biological systems; and space sickness.

*For related information see:* 14 Human Behavior; and 28 Space Radiation.

**N63-13806** European Atomic Energy Community, Brussels (Belgium)

**L'ÉVOLUTION DU POIDS DES ORGANES DU CORPS HUMAIN, DE LA NAISSANCE A L'AGE ADULTE, EN EUROPE OCCIDENTALE [THE EVOLUTION OF THE WEIGHT OF THE ORGANS OF THE HUMAN BODY, FROM BIRTH TO ADULT AGE, IN WESTERN EUROPE]**

Claudine Fabry 1963 104 p 50 refs
(Contract EURATOM 003-61-10 PSAF)
(EUR-147.f)

The purpose of this program is to collect already existing anatomical evaluations for each organ of the human body at the different ages of life, bring out the most probable average values, and then propose a standard diagram of weight evolution of man from birth to adult age. If possible, standard values were deduced from experimental determinations, or a theoretical way is suggested as substitute. When available data were sufficient, a standard diagram of growth variation, representative for the European Community, was developed. It will be seen that in some cases this standard is quite different from the American one. Author

**N63-13825** Aerospace Medical Div. School of Aerospace Medicine, Brooks AFB, Tex.

**PATHOGENIC MECHANISMS IN GAS AND FAT EMBOLISM**

James F. Wittmer Sept. 1962 29 p 69 refs

(*Its* Aeromedical Reviews 4-62)

"Pure" gas embolism, "pure" fat embolism, and dysbarism are compared, with emphasis given to the circulatory pathways by which the emboli can be distributed. Emphasis is placed on pointing out the similarities between these forms of embolisms because this knowledge is important to physicians treating aviators, divers, and caisson workers. These individuals are exposed to changes in barometric pressure that often produce embolic symptoms. A.R.B.

**N63-13854** Naval Radiological Defense Lab., San Francisco, Calif.

**DIFFERENTIAL RADIOSENSITIVITY OF FIRST- AND SECOND-SET RESPONSES TO ALLOGENIC AND XENOGENIC SKIN GRAFTS IN LETHALLY IRRADIATED MICE**

M. L. Tyan and L. J. Cole Feb. 5, 1963 20 p 23 refs

(USNRDL-TR-619)

Two consecutive BALB/c mouse- or rat-skin tail grafts were placed on 12- to 14-week-old female $LAF_1$ mice. One week following the rejection of the second graft, the mice received 870 rad whole-body X-radiation and an intravenous infusion of isogenic bone marrow. At various times following irradiation (0.2, 2.0, 13, and 30 days), groups of mice received orthotopic tail-skin grafts from $LAF^1$, BALB/c and C3D/2 mice, and Sprague-Dawley rats. The resulting data demonstrated the differential radiosensitivity of first- and second-set responses to either allogenic (H-2 difference) or xenogenic (rat) skin grafts; that is: the second-set response of mice presensitized with either allogenic or xenogenic skin grafts is more radioresistant than is the first-set response; the second-set response to a xenogenic skin graft is more radioresistant than is that to an allogenic graft; the converse appears to be true with regard to the first-set response. The theoretical implications of these findings are discussed. Author

**N63-13937** Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio

**ENDORADIOSONDES: A STATE OF THE ART SURVEY [Final Report, June-Sept. 1962]**

Michael Mc Cally and George W. Barnard Dec. 1962 13 p 35 refs

(AMRL-TDR-62-122) OTS: $0.50

Within the last 5 years endoradiosondes or "radio pills," have been developed employing tiny transducers and transmitters which can be swallowed or implanted in man and animals. The present state of the art of these instruments, including design, construction, uses, advantages, and limitations, is reviewed. The literature in this area, to date, consists largely of suggestions for design principles and considerations of circuitry. There is only the barest amount of useful data on equipment performance, reliability, response linearity, frequency response characteristics, and correlation with proven systems. The endoradiosonde promises to be a useful technique in physiological instrumentation, but much basic development remains to be done before this tool can be useful to any but the bioelectronic specialist. Author

**N63-13938** Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio

**EFFECT OF VAPOR PRESSURE ON PHYSIOLOGIC STRAIN AND BODY HEAT STORAGE [Final Report]**

John F. Hall, Jr. Dec. 1962 12 p 14 refs

(AMRL-TDR-62-147) OTS: $0.50

Physiologic strain in terms of body heat storage and other physiologic responses were measured and compared in two series of heat stress experiments performed on human subjects exposed to different ambient vapor pressures. One group of 75 experiments conducted on 5 healthy, nonacclimatized male subjects exposed five times each to 38°, 54°, and 71° C at 10 mm Hg vapor pressure was compared with a series of 81 experiments performed on 10 similar subjects exposed 1 to 6 times each to 38°, 41°, and 54° C at 20 mm Hg vapor pressure. Exposure times were 180, 120, and 60 minutes, respectively. Subjects were sitting and wore 1.0-clo insulation. The data show relations between body-heat storage and (a) the modified Craig index of physiologic strain, (b) overall sweat rate, (c) evaporative rate, (d) sweat-evaporative ratio, (e) mean skin and rectal temperatures, and (f) change of heart rate at the respective vapor pressure levels. Statistically significant correlation between sweat-evaporative ratio and overall sweat rate with body-heat storage is shown. Use of the overall sweat response as a physiologic strain index is suggested. Author

**N63-13946** RAND Corp., Santa Monica, Calif.

**A SURVEY OF EXOBIOLOGY**

Paul G. Seybold Mar. 1963 48 p 178 refs

(Contract AF 49(638)-700; Proj. RAND)

(RM-3178-PR)

The term "exobiology" was coined by Joshua Lederberg to describe investigations into the possibility of life existing outside the Earth. This paper comprises a referenced survey of current thought on this subject, with some attention being paid to the role of exobiology in the national space program. Specific topics considered are (1) the origin of life on the Earth, (2) chemical considerations for life, (3) the suitability of the planets of the solar system for indigenous life, (4) the contamination problem, (5) instrumentation for detecting extraterrestrial life, and (6) the possibility of the existence of intelligent extraterrestrial life forms. A bibliography on these topics is appended. This survey indicates that in the entire field of exobiology speculations vastly outnumber scientific facts, the extreme case being the subarea dealing with the existence of intelligent forms of extraterrestrial life. The questions of most immediate interest, and areas where experimental progress appears most promising, are concerned with (1) the existence of life forms, primitive or otherwise, on Mars, and (2) the origin of organic matter found in a small fraction of meteorites. Author

**N63-14072** Bureau of Medicine and Surgery, Washington, D.C.

**SUMMARY: THE HUMAN THERMOSTAT—TEMPERATURE, ITS MEASUREMENT IN SCIENCE AND INDUSTRY**

T. H. Benzing [1962] 2 p Submitted for Publication

(NASA Orders R-8 and R-38)

OTS: $1.10 ph, $0.80 mf

The human mechanisms of temperature regulation in warm and in cold environments have been resolved in quantitative terms of reproducible stimuli and responses. The mechanisms were analyzed with the aid of continuous recorders for cranial temperature, heat loss (gradient layer calorimetry), and heat production (oxygen consumption). The mechanism of "physical" temperature regulation consisted of sudomotor and vasomotor responses to warm stimulation of the internal system while the mechanism of "chemical" temperature regulation consisted of responses to the stimulus of cold at the skin. This indicates the presence of a centrally located organ (temperature-eye) in the brain, which exerts a tight control over temperature regulation in the human. R.C.M.

**N63-14177** Southwest Research Inst., San Antonio, Tex.

**A STUDY OF MICROBIOLOGICAL WASTE TREATMENT TECHNIQUES**

Frederick W. Bieberdorf Wright-Patterson AFB, Ohio, Biomedical Lab., Nov. 1962 88 p 24 refs

(Contract AF 33(616)-8153)

(AMRL-TDR-62-142) OTS: $2.25

A number of chemical and microbiological methods for the disposal of human wastes have been surveyed. On spaceflights of moderate duration (ca 100 to 1000 days), it would be most practical to treat the wastes with biocides and store them after dehydration for recovery of the water. On longer flights, the wastes either must be

chemically or microbiologically oxidized so that the carbon and chemically bound water could be recovered and used in photosynthesis. Chemical oxidation is more rapid and complete but requires the use of elaborate equipment and the possible expenditure of some heat energy. Microbiological degradation is slower but takes place at a lower temperature. When used in conjunction with a photosynthetic step, this might be the best solution to the problem for use of lunar colonies or prolonged space voyages. A procedure is suggested by which algal and bacterial colonies separated by semipermeable membranes could be used for waste digestion and reutilization of the carbon. An alternative to this procedure is suggested in which methane-utilizing bacteria and algae are used symbiotically, for the conversion of wastes to protoplasm, with a minimum expenditure of energy. Author

# 17 MACHINE ELEMENTS AND PROCESSES

Includes: bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control; and materials fabrication, handling, and inspection.

*For related information see:* 06 Auxiliary Systems.

**N63-13819** Joint Publications Research Service, Washington, D.C.
**CLASSIFICATION OF ELECTROTHERMIC EQUIPMENT FOR THE HEAT TREATMENT OF METALS**
M. A. Shevtzov and A. P. Al'tgauzen (VNIIETO) Apr. 16, 1962 27 p Transl. from Metalloved. i Term. Obrabotka Metal. (Moscow), no. 12, 1961
(JPRS-13459) Distributed by OTS

A classification of electrothermic equipment, which makes it possible to reduce the number of furnace types having similar parameters and possessing other common construction characteristics, is as follows: all-purpose electric-resistance furnaces using metal heating coils; electric-resistance furnaces with retractable hearth and metal heating coils; all-purpose electric resistance pit furnaces with metal heating coils; capped electric-resistance furnaces; general-purpose electrode salt-bath furnaces; unmuffled pit furnaces for gas carburization; drum-type furnaces for continuous-flow gas carburization; push furnaces; conveyor-type hardening-annealing furnaces; furnaces with a roller-track hearth; and vacuum-resistance furnaces for intermittent operation. I.v.L.

**N63-13844** Raytheon Co. Missile Systems Div., Bedford, Mass.
**PYROFIBER, FREE-STANDING, PYROGRAPHITE AND PYROCARBIDE. TASK III: PYROCARBIDES RESEARCH AND DEVELOPMENT Final Report, 14 November 1959-31 January 1963**
[1963] 139 p 35 refs
(Contract NOrd-19135(FBM))
(S-515)

Process conditions have been determined for the manufacture of massive pieces, as well as for the coatings, of the various refractory pyrolytic carbides. Property measurements were made on the parameters bearing on missile applications for these materials. Pyrolytic graphite-carbide composites were found to have greater strength at elevated temperatures than any other known substance. Small-scale rocket nozzles have been fabricated and tested under conditions simulating an actual firing. The pyrolytic carbides show great promise for use in the most severe environments; however, further research is necessary to achieve their maximum potential. Author

**N63-13925** General Dynamics/Astronautics, San Diego, Calif.
**STANDARD SPACE LAUNCH VEHICLE RELIABILITY IMPROVEMENT PROGRAM [Second Monthly] Progress Report**
Jan. 1, 1963 18 p
(Contract AF 04(694)-240)
(Rept. AOL-62-0049-1)

The program to improve reliability of standard launch vehicles covers the following: design assurance, model program, prediction, human factors and maintainability, parts and materials requirements, preferred parts lists, parts control, supplier reliability, reliability testing, and failure history reporting. R.C.M.

**N63-13948** Aberdeen Proving Ground. Ballistic Research Labs., Md.
**A PROCESS FOR THE PREPARATION OF NITROCELLULOSE PROPELLANTS IN THE DENSITY RANGE OF 0.8 TO 1.3 g/cc**
J. E. Cole and E. C. Adams Jan. 1962 18 p
(BRL-TN-1487)

A method is described for the preparation of porous nitrocellulose propellant in the density range 0.8 to 1.3 g/cc. Density gradient and shrinkage of the propellant is discussed. Values are given for heat stability and drop height sensitivity. Author

**N63-13980** Massachusetts Inst. of Tech., Cambridge
**JOINING OF REFRACTORY METALS—TUNGSTEN Final Report**
J. H. Brophy, H. Heideklang, P. Kavach, and J. Wulff Mar. 30, 1962 59 p 34 refs
(Contract DA-19-020-ORD-5236)
(WAL-TR-460.54/1-2)

Concepts of activated tungsten diffusion have been applied to the joining of tungsten strip at temperatures ranging from 900° to 1100° C. Solid-state diffusion has been enhanced by electroplating a thin layer of either nickel or palladium on one of the mating surfaces. Assemblies were made by heat treating in a high-temperature vise or by spot welding followed by a diffusion treatment. Joints were in sandwich, single-lap, or double-lap geometries. Fractography, metallographic examination, bend tests, and tensile shear loading tests indicated that bonding could be accomplished at temperatures as low as 1000° C. The structure was typically partially recrystallized but free of thermal cracks. The joints were brittle at room temperature, but specimens heated to 2200° C remained capable of bearing a load. A brief theoretical discussion and an interpretation in the light of other joining techniques have been offered. Author

**N63-13981** Martin-Marietta Corp. Electronic Systems and Products Div., Baltimore, Md.
**RELIABILITY TECHNIQUES APPLIED TO ELECTRONIC SYSTEMS**
Paul H. Zorger and S. J. Hornyak [1962] 77 p 12 refs Presented to Air Force Inst. of Tech., Air U., Graduate Class in Reliability, Baltimore, Sept. 13-14, 1962
(ER-12759)

This presentation deals with the application of reliability techniques which are used in the design and development of electronic equipment, especially large and complex units, such as command and control systems. The discussion is divided into three principal areas: (1) the overall consideration of reliability as it relates to system effectiveness, and the use of Markovian and stochastic processes as they relate to operational reliability; (2) an approach to determining the reliability of a design and/or product, and the use of computers as related aids; and (3) the tradeoffs and integration of cost, maintainability, and other disciplines which are considered in reliability determinations. Author

**N63-13998** National Research Council of Canada. Div. of Mechanical Engineering, Ottawa
**CENTRIFUGAL COMPRESSORS**

H. S. Fowler and C. K. Rush *In* National Research Council of Canada Quarterly Bulletin of the Division of Mechanical Engineering and the National Aeronautical Establishment, 1 October to 31 December 1962 p 35-54 (See N63-13997 09-01)

A history of centrifugal compressor development is given along with the following: compressor parameters used in analysis; compressor laboratory tests; and low-temperature testing rig. R.C.M.

# 18 MATERIALS, METALLIC

Includes: cermets; mechanical and physical properties of alloys and metals; and metallurgy.

*For related information see:* 07 Chemistry; 17 Machine Elements and Processes; 19 Materials, Non-metallic; 33 Stresses and Loads; and 34 Structural Design.

**N63-13808** European Atomic Energy Community, Brussels (Belgium)

**CONTRIBUTION A L'ETUDE DE LA FRAGILITÉ A CHAUD DU MATERIAU COMPOSITE ALUMINIUM-ALUMINE [CONTRIBUTION TO THE INVESTIGATION OF HIGH-TEMPERATURE BRITTLENESS IN THE ALUMINIUM-ALUMINA COMPOSITE]**

P. Bonnet and M. Grin Joint Nuclear Research Center, Ispra Establishment (Italy), Metallurgy and Ceramics Service, Feb. 1963 40 p 14 refs In French; English abstract

(EUR 208.f) Available from Belgian American Bank and Trust, N.Y., account no. 121.86: 60 Belg. Fr.

This report presents the results of tests effected on the composite material aluminum-alumina. The results show that properties of this material change with temperature, particularly that of brittleness at high temperature. An examination of the samples proved that the presence of intermetallic compounds, due to the impurities of base aluminum, seems to be one of the causes of this brittleness. A hypothesis is proposed to give an explanation of these phenomena. Author

**N63-13822** Joint Publications Research Service, Washington, D.C.

**NEW STEELS AND ALLOYS**

A. S. Kaplan, N. N. Kozlova, and A. R. Krylove May 28, 1962 7 p Transl. from Standartizatsiya (Moscow), no. 2, Feb. 1962 p 50-52

(JPRS-13987) Distributed by OTS

The new steels and alloys available in the Soviet Union are discussed along with their applications. The discussion includes corrosion-resistant, heat-resistant, and high-temperature groups. R.C.M.

**N63-13839** California U., Berkeley. Minerals Research Lab.

**THERMODYNAMIC PROPERTIES OF METALS AND ALLOYS**

1962 114 p refs

Data sheets on the thermodynamic properties of metals and alloys are presented. M.P.G.

**N63-13958** General Electric Co. Space Power and Propulsion Section, Cincinnati, Ohio

**ALKALI METALS BOILING AND CONDENSING INVESTIGATIONS Quarterly Report No. 1, Covering the Period July 1, 1962 thru September 30, 1962**

[1962] 70 p 15 refs

(NASA Contract NAS3-2528)

OTS: $6.60 ph, $2.30 mf

This program is being conducted to obtain two-phase heat-transfer data for sodium and potassium under conditions of boiling and condensing. In addition, information related to pressure drop, flow stability, and two-phase flow characteristics will be obtained. Test section development and materials studies related to the experimental work are to be conducted as a support effort. To assist in correlation of data, a determination of surface tension of potassium and sodium will be made. Author

**N63-13973** Battelle Memorial Inst., Columbus, Ohio

**ANNEALING STUDIES ON IRRADIATED TYPE 347 STAINLESS**

William E. Murr and Frederic R. Shober Mar. 6, 1963 51 p 4 refs

(Contract W-7405-eng-92)

(BMI-1621) OTS: $1.25

The effects of 1-hour anneals at 1000° and 1800° F on the mechanical properties of Type 347 stainless steel specimens taken from the ETR J-10 pressure tube after fast-neutron (>1 Mev) exposures of about $7.1 \times 10^{21}$ nvt were studied. The pressure tube operated at a maximum temperature of about 750° F in a stressed condition. Testing was carried out at 75° and 750° F. Uniform elongations were increased from approximately 1 percent in the as-irradiated material to 15 and 25 percent, respectively, by the 1000° and 1800° F anneals. The 1000° F annealing appeared to produce a better combination of mechanical properties. The microstructure of unirradiated, as-irradiated and postirradiation-annealed specimens were very similar except for two specimens inadvertently heated above 1800° F during annealing. Author

**N63-14002** California U., Berkeley

**THERMAL PROPERTIES OF ALLOYS AT HIGH TEMPERATURES Final Report**

Raymond L. Orr and Ralph Hultgren Mar. 1, 1963 11 p 11 refs

(Contract AF 49(638)-83)

(Its Ser. 137, Issue 8)

A newly developed high-temperature heat-content calorimeter and the heat content data obtained with the unit for pure metals are discussed. The calorimeter uses diphenyl ether as the working substance and operates at a temperature of 27° C. Heat contents are determined at absolute temperatures up to 1450° K with an average precision of about ±0.3%; the measurements are rapid and require a minimum of calculation and correction. Heat contents, $H_T^\circ - H_{298}^\circ$, have been measured and the other thermal properties, Cp, $S_T^\circ - S_{298}^\circ$, and $F_T^\circ - H_{298}^\circ/T$, have been evaluated for Ag, Al, Au, Bi, Cu, Ni, Pb, Pd, Si, Cr, Fe, Hf, Pt, and Tl. A.R.B.

**N63-14056** Armour Research Foundation, Chicago, Ill.

**DIFFUSION IN TITANIUM AND TITANIUM ALLOYS [Final] Technical Documentary Report [Nov. 1, 1960 - Feb. 28, 1962]**

Rodney P. Elliott Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, Oct. 1962 65 p 33 refs

(Contract AF 33(616)-7656)

(ARF-2208-16; ASD-TDR-62-561)

The self-diffusion of titanium and the interdiffusion of aluminum, zirconium, molybdenum, vanadium, and oxygen in titanium have been investigated in the temperature range 600°-1300° C. Diffusion couples were prepared by roll-bonding or press-bonding techniques. Electron microprobe methods were used to determine the penetration of the substitutionally dissolved solutes; vacuum fusion analysis was used to determine the penetration of interstitially dissolved oxygen. Author

**N63-14078** California U., Berkeley. Materials Research Lab.

**DILATION CONTRIBUTION TO HEAT CAPACITY OF METALS AND ALLOYS Technical Note No. 7**

number of erase, reverse, and help operations called for by the student, and the rate of data input to the central computer. Because of an inadequate statistical sampling (only 10 students participated in the instruction sequence) the only conclusion that can be drawn is that operating the keyset did not distract the student's attention from the lesson material. M.P.G.

**N63-13816** Radio Corp. of America. RCA Labs., Princeton, N.J.
**THRESHOLD LOGIC IN ARTIFICIAL INTELLIGENCE Scientific Report No. 6**
R. O. Winder Nov. 15, 1962 30 p 50 refs
(Contract AF 19(604)-8423)
(AFCRL-63-6)

Threshold logic is the mathematical study of a class of logical functions which have been widely used in the field of artificial intelligence. These functions have been called threshold functions, linear-input functions, majority functions, etc., and are identical with the functions realized by the McCulloch-Pitts neuron. The first part of the report compares a standard probabilistic approach for the synthesis of such a device with a (more successful) new switching theoretic method. A survey of threshold logic is presented. Author

**N63-13833** Moscow State U. (U.S.S.R.)
**THE DETERMINATION OF BODY SHAPES OF MINIMUM DRAG USING THE NEWTON AND THE BUSEMANN PRESSURE LAWS**
G. G. Chernyi and A. L. Gonor [1962] 19 p 7 refs Presented at the Boeing Sci. Res. Labs. Symp. on Extremal Problems in Aerodynamics, Seattle, Dec. 3-4, 1962

Results of an investigation to determine airfoils and bodies of revolution with minimum drag, using Busemann's formula, indicate that the drag of an elliptical cone at Mach number 4 decreases with the increasing eccentricity of its cross section. Results of an investigation to determine three-dimensional body shapes of minimum drag, using the Newton pressure law, indicate that: a great number of various bodies of minimum drag can be constructed from one original body; and from a mathematical point of view, these bodies will have contours with discontinuous dependence of radius on angle, and from a physical point of view they will have additional surface of friction. I.v.L.

**N63-13834** Harvard U., Cambridge, Mass.
**NEWTONIAN SLENDER-BODY THEORY OF FLOW AROUND MINIMUM DRAG SHAPES**
Julian D. Cole [1962] 38 p 5 refs Presented at the Boeing Sci. Res. Labs. Symp. on Extremal Problems in Aerodynamics, Seattle, Dec. 3-4, 1962
(Sponsored by AFOSR)

This review includes: the concept of unsteady analogy for high-speed flow; the derivation of the Newton-Busemann pressure formula; the direct solution of the minimum drag problem for a given length and thickness; and the mathematical formulation of the Newtonian theory. I.v.L.

**N63-13835** Aeronautical Research Labs., Wright-Patterson AFB, Ohio
**A GENERAL METHOD FOR THE DETERMINATION OF BEST SUPERSONIC ROCKET NOZZLES**
K. G. Guderley and John V. Armitage [1962] 43 p 3 refs Presented at the Symp. on Extremal Problems in Aerodynamics, Boeing Sci. Research Labs., Seattle, Dec. 3-4, 1962

The paper presents a formulation of the problem of obtaining nozzles of maximum thrust for which an isoperimetric condition is imposed. The flow differential equations are considered as additional constraints which are incorporated into the problem by means of Lagrange multipliers. The conditions obtained from this formulation are made the basis of a numerical procedure from which the desired nozzle shape can be obtained by an iterative process. It is expected that many variational problems of a technical nature which would require to solution of nonlinear partial differential equations can be treated in a similar fashion. An obvious extension would concern fuselage shapes of minimum drag for which a general isoperimetric condition is prescribed. Author

**N63-13842** Aeronautical Research Council (Gt. Brit.)
**SEAPLANE IMPACT—A REVIEW OF THEORETICAL AND EXPERIMENTAL RESULTS**
T. Arlotte, P. Ward Brown, and P. R. Crewe London, HMSO, 1962 81 p 70 refs
(ARC-R&M-3285; previously issued as ARC-20617, ARC-18843) Available from HMSO: £1. 12s. 6d.

Full-scale impact tests made on a Sunderland at the Marine Aircraft Experimental Establishment were in disagreement both with basic model tests and existing theoreties. The existing information on theoretical, model, and full-scale work has therefore been examined. Detailed considerations were limited to a few selected numerical examples of impact but the treatment was kept as general as possible. The report shows that the total impact force can be calculated from an equivalent planing force defined by the forward speed draught and incidence multiplied by a factor to allow for vertical velocity. The value of the planing force is then normally deducible from quasi-static conditions of planing-force measurements, but extrapolation still depends on associated mass assumptions. When reasonable assumptions can be made of the appropriate pressure distributions for individual hull forms, one example shows quite good agreement. It may therefore be that it will be necessary for some time to determine the three-dimensional planing forces and pressures experimentally on models of individual hull forms in order to deduce full-scale impacts. Even then, care will be required in correcting for dynamic effects such as rotation and flow suctions. Author

**N63-13921** Illinois U., Urbana
**AN APPLICATION OF NUMERICAL ANALYSIS FOR A METHOD OF CONFORMAL MAPPING AND THE DETERMINATION OF STRESSES IN SOLID-PROPELLANT ROCKET GRAINS**
C. C. Fretwell Feb. 1963 94 p
(T&AM-241)

The report is concerned with an application of numerical analysis, using the IBM 7090 digital computer, to a method of conformal mapping and the determination of stresses in solid-propellant rocket grains. Author

**N63-13922** Argonne National Lab., Ill.
**RESULTS OBTAINED FROM THE FRICKE DIFFUSION KINETICS CODE**
Erwin H. Bareiss, Cynthia Chamot, and Hugo Fricke Sept. 1962 59 p 3 refs
(Contract W-31-109-eng-38)
(ANL-6560)

The Diffusion Kinetics Codes described in ANL-6556 were used to study hypothetical reactions of free radicals produced by passing $\alpha$ rays and $\gamma$ rays through aqueous solutions. Tables and graphs of results are given for about 200 cases that were run on the IBM 704 with various parameter combinations. Intermediate as well as final concentrations are given for some $\gamma$-ray cases. Author

**N63-13923** University of Southern Calif. Engineering Center, Los Angeles
**A STUDY ON THE EQUATIONS GOVERNING GAS FLOW IN A LOW-DENSITY NOZZLE**
F. E. Mickey Arnold Engineering Development Center, Mar. 1963 101 p 41 refs
(Contract AF 40(600)-897)
(USCEC-R-78-101; AEDC-TDR-63-59)

A study is made to develop an approximate numerical method suitable for predicting the flow of a viscous, heat-conducting gas in a low-density nozzle under conditions of low Reynolds number and arbitrary wall temperature. Four partial differential equations—continuity, energy, x- and y-momentum — are taken to govern the gas flow in a two-dimensional region. It is assumed that the dependent variables of the equations—density, temperature, x- and y-components of velocity—can be approximated by finite double power series in the space variables, x and y. Sets of nonlinear algebraic equations are developed to approximate the governing equations, and, by combining these with appropriate boundary conditions, the problem is reduced to solving a set of simultaneous algebraic equations, a task well suited to a high-speed digital computer. A preliminary result is presented; the method is used to predict the flow in the throat region of supersonic nozzle. The prediction is found to be unsatisfactory, and the difficulty is shown to be due to the invalidity of an assumption used in approximating the governing equations. An alternative method of solution that might circumvent the difficulty is suggested. Also considered briefly are variations of the equations of a viscous, heat-conducting gas that result when the two parameters of the governing equations, the pseudo-Reynolds number and the Prandtl number, are given the limiting values of 0 and/or ∞. Author

**N63-13933** Bettis Atomic Power Lab., Westinghouse Electric Corp., Pittsburgh, Pa.

**PDQ-5—A FORTRAN PROGRAM FOR THE SOLUTION OF THE TWO-DIMENSIONAL NEUTRON-DIFFUSION PROBLEM. PART I: STEADY-STATE VERSION**

W. R. Codwell Feb. 1963 33 p 7 refs
(Contract AT-11-1-GEN-14)
(WAPD-TM-363) OTS: $0.75

The steady-state version of PDQ-5, written in FORTRAN II language, is discussed. Topics covered are: few-group neutron-diffusion equations solved by PDQ-5 for single and double thermal group problems; editing functions; filetape operation; input and output to the program; general operating instructions for PDQ-5. A.R.B.

**N63-13934** Bettis Atomic Power Lab., Westinghouse Electric Corp., Pittsburgh, Pa.

**NUMERICAL METHODS AND TECHNIQUES USED IN THE TWO-DIMENSIONAL NEUTRON-DIFFUSION PROGRAM PDQ-5**

L. A. Hageman Feb. 1963 87 p 24 refs
(Contract AT-11-1-GEN-14)
(WAPD-TM-364) OTS: $1.75

A description is given of the mathematical theory and methods used in the PDQ-5 program to obtain the numerical solution to the few-group, time-independent, neutron diffusion equations in two dimensions. The finite difference approximations of the continuous problem for both x-y and r-z geometries and the properties of the resulting matrix problem are given. The mathematical features and the practical applications of the numerical methods used to solve the matrix problem are discussed. Author

**N63-13935** RAND Corp., Santa Monica, Calif.

**CHANDRASEKHAR'S X AND Y FUNCTIONS FOR HOMOGENEOUS ATMOSPHERES**

T. W. Mullikin Dec. 1962 52 p 15 refs
(NASA Contract NAS7-100)
(RM-3376-JPL) OTS: $5.60 ph, $1.76 mf

This memorandum presents a practical method for computing Chandrasekhar's X and Y functions. These functions determine scattering and transmission functions for a certain radiative transfer problem for homogeneous plane-parallel atmospheres. In a previous memorandum, it was shown that Chandrasekhar's nonlinear integral equations for X and Y functions fail to specify a solution in many cases. In this study additional equations are obtained, as linear constraints, which serve to complete these equations. By use of the theory of singular integral equations and analytic continuation, the X and Y equations and the added constraints are transformed into equations which provide a practical computational procedure. These results can be viewed as being obtained by an extension of the Wiener-Hopf methods (Laplace transform methods) to atmospheres of finite thickness. Author

**N63-13940** Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro

**RÉSULTATS RÉCENTS ET PROBLÈMS DE NATURE ALGÉBRIQUE EN THÉORIE DE L'APPROXIMATION (RESUME) [RECENT RESULTS AND PROBLEMS OF AN ALGEBRAIC NATURE IN THE THEORY OF APPROXIMATION (A Summary)]**

Leopoldo Nachbin (Brazil U.) 1962 6 p 6 refs In French Presented at the International Cong. of Mathematicians, Stockholm, Aug. 15-22, 1962
(*Its* Notas de Física, v. 10, no. 2)

The Weierstrass approximation problem for differential functions and the Bernstein approximation problem for continuous functions are discussed. A.R.B.

**N63-13947** Aberdeen Proving Ground. Ballistic Research Labs., Md.

**THE SIMULATION OF INTERIOR BALLISTIC PERFORMANCE OF GUNS BY DIGITAL COMPUTER PROGRAM**

Paul G. Baer and Jerome M. Frankle Dec. 1962 59 p 18 refs
(BRL-1183)

When nonconventional guns are to be considered or when detailed design information is required, interior ballistic calculations become more difficult and time-consuming. To deal with these problems, the equations which describe the interior ballistic performance of guns and gun-like weapons have been programed for the high-speed digital computers available at the Ballistic Research Laboratories. The major innovation contained in the equations derived in this report is the provision for use of propellant charges made up of several propellants of different chemical compositions and different granulations. Results obtained by the method described in this report compare favorably with those of other interior ballistic systems. In addition, considerably more detail is obtained in far less time. A comparison with experimental data from well-instrumented gun-firings is also presented to demonstrate the validity of this method of computation. Author

**N63-13964** General Dynamics/Astronautics, San Diego, Calif.

**NUMERICAL ANALYSIS OF SMALL FINITE AXISYMMETRIC DEFORMATION OF THIN SHELLS OF REVOLUTION**

P. E. Wilson and E. E. Spier June 1, 1962 69 p 42 refs
(ERR-AN-153)

Two basic nonlinear differential equations that govern small finite axisymmetric deflections of thin linearly elastic and isotropic shells of revolution are derived. The two ordinary differential equations, which form a fourth-order system, are coupled in a dimensionless stress function and the rotation of a meridional tangent. Surface loading, temperature, and shell thickness may vary along a meridian and, in addition, temperature may vary through the thickness. First-order central difference approximations are used to reduce the two differential equations to finite difference form. The resulting nonlinear difference equations are written in a convenient matrix form, and solved by combining an iterative scheme with a direct elimination method that employs two-by-two coefficient matrices. Author

**N63-13975** Oak Ridge National Lab., Tenn.

**AN ALGOL 60 SYNTAX CHECKER FOR THE IBM 7090 COMPUTER**

M. P. Lietzke Mar. 21, 1963 28 p 1 ref
(Contract W-7405-eng-26)
(ORNL-3399) OTS: $0.75

A syntax checker was designed based on the syntax of Algol as described in the Algol 60 Report (ACM Communications, May 1960). Since the definition of the elements of the language is recursive, it was found desirable to design the syntax checker as a set of mutually recursive processors tied together by building blocks which perform certain bookkeeping functions. Because of the recursive nature of the language and of the syntax checker, the problem of recovery after an error required attention. A method was devised which permits most programs to be checked completely despite errors. The syntax checker has been implemented for the IBM 7090 as a part of the SHARE ALGOL processor, and has operated very satisfactorily. Author

**N63-13978** Northeastern U., Boston, Mass.

**MATHEMATICAL ANALYSIS OF COMPLEX SYSTEMS Final Report**

Ladislav Dolanský, Ralph E. Bach, Jr., and Samuel M. Giveen Sept. 30, 1962 99 p 38 refs
(Contract AF 19(604)-4573)
(AFCRL-63-38)

Under Project Numerics, various disciplines have been studied from the point of view of their applicability to complex-system analysis, and extended where possible. The research performed under Project Numerics is summarized. The following disciplines have been investigated: (a) queuing theory, (b) Lanchester theory of combat, (c) numerical methods, (d) game theory, (e) simulation, (f) Markov models, (g) linear graphs. Author

**N63-13985**

**A METHOD FOR CONSTRUCTION OF THE SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS WITH THE AID OF THE COMPLEX PLANE**

Seppo Rickman Repr. from Acta Polytech. Scand., Math. Computing Mach. Ser. (Stockholm), Ma 7 (AP 323), 1962 30 p 7 refs (*Its* Finnish Contribution 36) Available from Acta Polytechnica Scandinavica Publ. Office, Box 5073, Stockholm: Sw. Kr. 7.00

A partially graphic method for the solution of ordinary differential equations is presented, in which the Laplace transformation is employed to represent the state of the differential equation, at given intervals in the complex plane, by poles and zeros. This is possible owing to the procedure of assuming the differential equation to have constant coefficients in each interval. At first, the theory is carried through in its entirety in a coarse shape, determining the constant coefficients on the basis of the initial points of the intervals, whereas in the second approximation they are determined by the center-points of the intervals. As applications, one linear differential equation of the third order and two nonlinear differential equations of the second order are treated. Author

**N63-13996** Air Proving Ground Center, Elgin AFB, Fla.

**STUDY OF TARGET PENETRATION PREDICTION BY HIGH SPEED AND ULTRA HIGH SPEED BALLISTIC IMPACT Fifth Quarterly Report, July 1 - Sept. 30, 1962**

A. G. Bilek Mar. 1963 17 p 4 refs
(Contract AF 08(635)-2155)
(APGC-TDR-63-16)

The main effort has been directed toward "cleaning up" the empirical data used in the statistical analyses. An analysis of 1,034 shots, divided into 768 "high" velocity shots and 266 "low" velocity shots, shows that about 90% of the variation in penetration depth may be explained by a simple power-law formula utilizing four or five independent variables, including a target-strength parameter. Author

**N63-14001** Michigan U. Electron Physics Lab., Ann Arbor

**INVESTIGATION OF LARGE-SIGNAL TRAVELING-WAVE TUBES Quarterly Report No. 1**

G. T. Konrad, J. E. Rowe, et al Griffiss AFB, N.Y., Techniques Lab., Oct. 1962 79 p 18 refs
(Contract AF 30(602)-2834)
(RADC-TDR-63-8)

A digital computer program for a two-dimensional nonlinear analysis of large-signal traveling-wave devices is described. Comparison is made with the one-dimensional analysis. Experimental data on a variable-pitch traveling-wave amplifier is presented. Characteristics of the output coupler are shown to inhibit the efficiency enhancement. Cold-test data on the ring-and-bar circuit, which will also ultimately be used in phase focusing experiments, are presented. A theoretical analysis and construction techniques for the depressed potential collector are given. The digital computer programs for solid- and hollow-beam guns are described. Modifications to make the programs more general are suggested. The noise reduction mechanism in a beating-wave amplifier is treated theoretically and experimentally. The noise figure data is not conclusive due to a nonoptimum length for gain. Design characteristics and experimental results on the magnetron injection gun are given. Author

**N63-14052** Bettis Atomic Power Lab., Westinghouse Electric Corp., Pittsburgh, Pa.

**MO322 AND MO323—FORTRAN PROGRAMS FOR CALCULATING NEUTRON ABSORPTION IN SPHERES DISTRIBUTED RANDOMLY Interim Memorandum**

R. M. Cathwell Oct. 1962 32 p 1 ref.
(Contract AT-11-1-GEN-14)
(WAPD-TM-352) OTS: $0.75

These are one-energy, Monte Carlo calculations of the fraction of neutrons absorbed in spheres distributed randomly, in one case (MO322) in an otherwise infinite homogeneous medium, and in the other case (MO332) in one region of an otherwise one-dimensional, three-region cell. Author

**N63-14053** Office of Research Analyses. Mathematics Div., Holloman AFB, N. Mex.

**THE COMBINED EFFECT OF REFRACTION, DOPPLER SHIFT, ABERRATION, AND LIGHT DRAG ON SIGNALS REFLECTED FROM MISSILES Technical Report**

Bruno Manz Mar. 1963 36 p
(ORA-63-5)

The theory of the Doppler shift, aberration, and light drag is developed for heterogeneous refractive media. The basic principle is the invariance of the phase function under the Lorentz transformation. Various formulae are derived for electromagnetic signals going from an emitter, via a reflector, to a receiver, all signals having different velocities with respect to the heterogeneous refractive medium. Author

**N63-14059** Air Force Cambridge Research Labs. Electronics Research Directorate, Bedford, Mass.

**CAUSALITY, PHYSICAL REALIZABILITY, AND STABILITY Research Report**

E. J. Post Oct. 1962 52 p 40 refs
(AFCRL-62-779)

This report discusses conceptual similarities and differences between causality, physical realizability, and stability in an effort to coordinate some parallel and relevant developments in physics, engineering, and mathematics. The concept of causality emerges as the most fundamental of the three. Special attention has been given to limiting cases of lossless or almost lossless systems. Mathematical singularities arising in these limiting cases are treated in terms of the theory of generalized functions and regular sequences. The phase-gain description of systems has been modified to match the symmetry and uniqueness of the more customary "immittance" description. Author

**N63-14070** Rensselaer Polytechnic Inst., Troy, N.Y.
**A DIGITAL ORTHOGONAL MODEL FOR NONLINEAR PROCESSES WITH TWO-LEVEL INPUTS**
Rob Roy and Paul M. DeRusso [1962] 34 p 19 refs Submitted for Publication
(NASA Grant NsG-244-62 (Related))
OTS: $3.60 ph, $1.22 mf

This paper describes a method by which the class of nonlinear processes with switched two-level inputs and finite settling times can be identified and an adaptive model of the process constructed. The adaptive model uses only the process input-output records. After a suitable identification time (approximately 14 to 70 times the settling time of the process) the model approximates the plant performance using a mean square error criteria and tracks any changes in the plant parameters. The past of the two-level input is stored in a digital shift register tapped at n points, thus forming a function space comprised of $2^n$ nonoverlapping or orthogonal cells. By averaging the output waveform during the time that a cell is occupied, a coefficient is obtained which characterizes the output for that input condition. A basic assumption about the input waveform statistics reduces the number of characterizing coefficients from 1024 to approximately fifty. The model that is evolved is a small synchronous digital computer. The model is quite versatile as it is independent of the type of process nonlinearity and can adapt to systems with different settling times. The model is ideal for use in predictive adaptive control systems where a fast time predictive model is utilized. Author

**N63-14108** Mitsubishi Electric Mfg. Co., Ltd. Research Lab., Amagasaki (Japan)
**FREQUENCIES OF COMMANDS USED IN SINGLE ADDRESS COMPUTER**
Yoshiaki Tsuboi and Takayuki Kimura *In its* Mitsubishi Denki Laboratory Reports, Vol. 4, No. 1 Jan. 1963 p 51-63 (See N63-14104 09-01)

Important characteristics of sequence of commands in programs, such as (1) the number of each command used, (2) the transition probability between two commands, (3) the number of commands between "Clear and Add" and "Store", and (4) the length between "Branch" commands have been investigated to obtain useful data for the design of new computers and program systems. About 10,000 commands have been examined, and some profitable results were obtained. Author

**N63-14120** Royal Aircraft Establishment, Farnborough (Gt. Brit.)
**APPROXIMATE FORMULAE FOR FLUTTER PREDICTION**
W. G. Molyneux *In* Advisory Group for Aeronautical Research and Development, Paris (France) Manual on Aeroelasticity. Part V. Factual Information on Flutter Characteristics [1961] 77 p 25 refs (See N63-14113 09-01)

A general approach for the approximate solution of flutter equations is discussed. Approximate formulae for binary and ternary flutter systems are developed and their limits of application are considered. I.v.L.

**N63-14183** Air Force Cambridge Research Labs. Geophysics Research Directorate, Bedford, Mass.
**COMPATIBILITY EVALUATION FOR PRINTED TAPE BUFFER EQUIPMENT**
Phillip I. Hershberg Sept. 1962 19 p 5 refs
(AFCRL-62-891)

The results of a testing program conducted to evaluate the compatibility of two specialized data-handling devices developed as printed-tape buffer equipment are discussed in this report. These equipments, the Distributor-Transmitter, Telecode AN/GGT-2, and the Electrographic Telecode Recorder AN/GTH-1, utilize a novel method of recording and, subsequently, transmitting high-speed communications line information. These units replace the commonly utilized punched-tape and magnetic-tape buffer units. The report describes the operation of these units and provides factual data as to their compatibility. Author

**N63-14184** Air Force Cambridge Research Labs. Geophysics Research Directorate, Bedford, Mass.
**COLLECTION OF COMPUTER PROGRAMS APPLICABLE TO METEOROLOGICAL DATA PROCESSING Research Note**
Wayne D. Mount, Eugene A. Bertoni, and Iver A. Lund Nov. 1962 61 p 2 refs
(AFCRL-62-1098)

This note describes nine programs written for the IBM 704 electronic computer in the FORTRAN language. The complete FORTRAN program listings and write-ups are presented, thereby enabling the reader to reproduce parts, or all, of the programs as he wishes. Author

**N63-14228** Polytechnic Inst. of Brooklyn. Microwave Research Inst., N.Y.
**PROBABILITY DISTRIBUTION AT THE OUTPUT OF A LOGARITHMIC RECEIVER**
Samuel Geldston Oct. 4, 1962 111 p 15 refs
(Grant AF-AFOSR-62-295)
(PIBMRI-1087-62)

A statistical study of the behavior of the logarithmic receiver in an environment of bandlimited white noise and signal-plus-noise is presented. The output probability densities, the means, variances, and higher moments are calculated for various input noise and signal levels. A significant feature of the logarithmic receiver is that the magnitude of the output variance about its mean value is independent of the magnitude of the input noise level, provided that the dynamic range is not exceeded. Thus, the combination of logarithmic receiver and high pass filter can be used as a technique for obtaining a constant false-alarm rate for systems operating in a noisy environment. Author

# 21 METEOROLOGY

Includes: climatology; weather forecasting; lower atmosphere studies; and oceanography.

*For related information see:* 05 Astronomy and Astrophysics; 12 Geophysics; and 29 Space Sciences.

**N63-13818** Washington U., Seattle
**APPLICATION OF RADAR DATA TO PROBLEMS IN SYNOPTIC METEOROLOGY Final Report**
Richard J. Reed and Carl W. Kreitzberg Dec. 1962 91 p 7 refs
(Contract AF 19(604)-5192)
(AFCRL-63-22)

The results of studies of squall line formation in two cases, for which hourly radar composites were available to assist in tracing and interpreting the developments, were summarized. In addition, an echo classification scheme is described for occluded cyclones. Also, the relationship of radar echoes to precipitation, cloud visibility, turbulence, and icing, reported by aircraft pilots airborne in the vicinity of the radar, is analyzed. B.J.C.

**N63-13927** Air Force Cambridge Research Labs. Geophysics Research Directorate, Bedford, Mass.

**LECTURES ON NUMERICAL WEATHER PREDICTION Research Report [Nov. 1961-Mar. 1962]**

Louis Berkofsky (Hebrew U.) July 1962 98 p 17 refs
(AFCRL-62-684)

This set of notes is based on a series of lectures presented at the Department of Meteorology of the Hebrew University of Jerusalem during 1961 and 1962. The topics are selected so as to trace the development of numerical models, from the geostrophic to the non-geostrophic. Application for prediction of specific phenomena, such as the hurricane and the sea breeze, is discussed. Emphasis is placed on discussion of integral constraints. Author

**N63-14068** McGill U. Arctic Meteorology Research Group, Montreal (Canada)

**80° W MEAN CROSS-SECTIONS, 1959–1960**

Jan Tissot Jan. 1963 44 p 4 refs
(Sponsored by Canadian Dept. of Transport Meteor. Branch, and USAF Geophysics Res. Dir.)
(Its Publ. in Meteorology 55)

Mean seasonal cross sections along 80 degrees west were constructed from daily analyzed data. By this procedure it was possible to formulate means and standard deviations with respect to various jet stream cores and selected temperatures, as well as the usual geographical means. A set of such sections for the period June 1959 to May 1960 is presented and discussed. Author

**N63-14091** Imperial Coll. of Science and Tech., London (Gt. Brit.)

**CUMULONIMBUS CONVECTION IN SHEAR Technical (Scientific) Note No. 12**

J. S. A. Green and R. P. Pearce Nov. 1962 76 p 7 refs
(Contract AF 61(052)-254)
(AFCRL-63-257)

A theoretical study is made of steady, frictionless, finite amplitude convection in an open system, associated with a model of cumulonimbus dynamics. Detailed analysis is confined to two space dimensions, and the shape of the flow is found to be determined mainly by a Richardson number. The effects of the density scale height, Coriolis forces, turbulent heat exchange, and water budget are also mentioned. Consideration of constraints implied by the mass and energy budgets of the system poses a nonlinear eigenvalue problem in which a level of no relative motion is determined. A fairly general solution is found, and this suggests three possible modes of working, depending on the Richardson number (Ri). A detailed flow pattern is tested for validity with respect to its thermal and kinematic properties. Temperature and flow fields representing a two-dimensional model of an observed cumulonimbus are found to be reasonably consistent with the heating that would be derived from latent heat released by condensation, and the cooling caused by evaporation from the rain. The critical nature of the water budget is emphasized, and it is reasoned that the fit between observation and theory would be improved if the motion were allowed the freedom of three space dimensions. Conditions in the interface regions are found to be rather complicated in both studies. Author

**N63-14095** Army Cold Regions Research and Engineering Lab., Hanover, N.H.

**Quarterly Progress Report, November 1962-January 1963 [PHYSICAL AND MECHANICAL PROPERTIES OF SNOW, ICE AND FROZEN GROUND]**

James A. Bender, R. W. Gerdel, and Paul R. Camp [1963] 6 p

The interrelationships of climatic and meteorological phenomena of polar environments and the physical and mechanical properties of snow, ice, and frozen ground were investigated. These studies included: measurement of the electrostatic charges on snowflakes, surface conductance measurements on ice, investigation of the isothermal flow of air through a snowpack, review of the physics of sea ice, assay of particulate matter isolated from deep ice cores, analysis of soil plasticity and frost heaving mechanisms, survey of soil movements in Greenland and glaciology in Antarctica, investigation of the particle dynamics of drifting snow, computation of the visual albedo and black-body radiation of snow, and the development of apparatus for laboratory simulation of clouds, fog, and snow. M.P.G.

**N63-14181** Air Force Cambridge Research Labs. Geophysics Research Directorate, Bedford, Mass.

**SUPPLEMENTAL ATMOSPHERES**

A. Court, A. J. Kantor, and A. E. Cole Sept. 1962 28 p 51 refs
(AFCRL-62-899)

Atmospheres typical of the tropics (15° N), subtropics (30° N), and midlatitudes (45° N) have been prepared as members of a family of atmospheres supplemental to the 1962 U. S. Standard Atmosphere; they provide information on latitudinal and seasonal changes in atmospheric structure up to 90 km. Author

**N63-14223** White Sands Missile Range. Inter-Range Instrumentation Group, N. Mex.

**DATA REPORTS OF THE METEOROLOGICAL ROCKET NETWORK FIRINGS, VOLUME X. WINTER 1961–62 FIRINGS**

Feb. 1963 263 p
(IRIG-109-62)

Wind temperature data for the winter season 1961 to 1962, collected from Meteorological Rocket Network firings are presented. Radiosonde observations made nearest the time of the rocket firings are presented for all cases for which these observations are available. M.P.G.

## 22 NAVIGATION AND GUIDANCE

Includes: autopilots; star tracking; inertial platforms; and traffic control.

*For related information see:* 06 Auxiliary Systems; 08 Communications; 09 Electronics; 10 Facilities; 15 Instrumentation; 20 Mathematics; and 29 Space Sciences.

**N63-14028** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**AN EMERGENCY MIDCOURSE NAVIGATION PROCEDURE FOR A SPACE VEHICLE RETURNING FROM THE MOON**

C. Dewey Havill Washington, NASA, Mar. 1963 31 p 3 refs
(NASA TN D-1765) OTS: $1.00

A manual emergency-navigation procedure for a vehicle returning from the moon is presented. The procedure involves photographing the earth from various positions along the trajectory returning from the moon, and deducing from image measurements the required midcourse corrections. Preliminary tests of the accuracy with which required image measurements can be obtained, together with machine computations of the overall accuracy of the guidance procedure, indicate the accuracy could be within the corridor depth of a lifting entry vehicle. Author

**N63-14102** Westinghouse Electric Corp. Air Arm Div., Baltimore, Md.

**MAGNETIC TORQUERS FOR SPACE VEHICLE CONTROL [Final Report]**

J. Braumiller, G. E. Lynn, P. M. Julich, and G. W. Wood Wright-Patterson AFB, Ohio, Flight Control Lab., Jan. 1963 165 p 10 refs
(Contract AF 33(657)-8190)
(ASD-TDR-63-74)

By controlling the currents in a group of three orthogonal coils fixed to the body of a satellite, a useful attitude-control torque can be produced by reaction with the earth's magnetic field. Such magnetic torquing can take the form of direct control of the vehicle momentum or of indirect control by removing the momentum accumulated in reaction wheels. Magnetic actuators have been found to be a reliable and lightweight means of satellite torquing. As might be expected, limitations in torque capability, and therefore of accuracy, are experienced when magnetic actuators are used alone in a direct control system. Torquers with ferromagnetic cores are superior to air-cored coils from a weight standpoint, and are superior to permanent magnet devices from either a controllability or a reliability standpoint, depending on the complexity of the latter. Design equations have been evolved by means of which optimum iron-cored actuators may be mechanized, and these equations have been confirmed by tests of experimental torquers. Also, the earth's magnetic field has been defined in terms of the coordinate axes of a vertically oriented satellite for a variety of orbits. Author

# 23 PHYSICS, GENERAL

Includes: acoustics; cryogenics; optics; and thermodynamics.

*For astrophysics see:* 05 Astronomy and Astrophysics.

*For related information see:* 12 Geophysics; 29 Space Sciences; 24 Physics, Plasma; and 24 Physics, Solid-State.

**N63-13796** Illinois U., Urbana

**MEASUREMENT OF PRESSURE IN AN ULTRA-HIGH VACUUM**

R. L. Heimburg, A. B. Huang, E. A. Jackson, T. J. Mueller, and S. L. Soo Arnold Engineering Development Center, Mar. 1963 142 p 141 refs
(Contract AF 40(600)-909)
(AEDC-TDR-63-49)

Measurement of pressure in an ultrahigh vacuum environment, including the effect of adsorption, multigage operation, and streaming was studied. The theory of the Bayard-Alpert gage was further explored. The concept of adsorption was further generalized. Response of a gage was studied. An experimental system has been devised capable of substantiating these points, as well as comparing a number of different ionization gages and determining the interaction of gages. Generalization of results permits rational gage interpretation in various environments. The usefulness of a nude gage for all measurements is demonstrated. Author

**N63-13809** European Atomic Energy Community, Brussels (Belgium)

**VERGLEICH DREIER METHODEN ZUR MESSUNG DER OBERFLÄCHENSPANNUNG VON POLYPHENYLEN (COMPARISON BETWEEN THREE METHODS OF MEASURING SURFACE TENSION IN POLYPHENYLS)**

G. Fritz and R. Nehlen Joint Nuclear Research Center, Ispra Establishment (Italy), Heat Exchanges Service, Feb. 1963 21 p 9 refs In German; English summary
(EUR-209.d) Available from Belgian American Bank and Trust Co., N.Y., account no. 121.86: 40 Belg. Fr.

The paper presents and compares the results of three methods for the determination of the surface tension of polyphenyls. These three methods are: horizontal capillary, bubble pressure method, and Lenard's wire method. The results of horizontal capillary and bubble pressure agree very well, which verifies that the liquids have zero contact angle. The wire-method shows that systematic errors are hard to prevent. A further development of the bubble pressure method to an absolute one is preferred. Author

**N63-13812** Arizona U., Tuscon

**MASKING AND SPEECH PRE-EMPHASIS Final Report**

John L. Stewart Wright-Patterson AFB, Ohio, Biomedical Lab., Mar. 1962 20 p 16 refs
(Contract AF 33(616)-7800)
(MRL-TDR-62-11)

A waveform processing representation for the subjective intensity of loudness is analyzed when a mixture of signal and noise exists. Signal suppression by noise constitutes partial masking. If a spatial pattern of excitation along the basilar membrane of the inner ear is interpreted in terms of the formant structure, preferential masking of certain formants is evidenced. Emphasis of high-frequency formants prevents differential masking. For noisy linear speech systems, an advantage of 4 db can be achieved by means of pre-emphasis of high-frequency components with a multislope pre-emphasis characteristic that varies from 0 db per octave to a maximum of 8 or 9 db per octave at high frequencies. The theory of differential masking is also applied to certain peak-clipped systems in which distortion due to clipping is equivalent to masking noise. A multislope pre-emphasis characteristic is predicted which varies from 0 db per octave to 12 db per octave at high frequencies. In addition to pre-emphasis data, the discussion contains a theory for masking and the elements of a pattern theory for speech-sound recognition. Author

**N63-13815** Watkins-Johnson Co., Palo Alto, Calif.

**RESEARCH ON GASEOUS OPTICAL MASER TO DEVELOP HIGH CONTINUOUS WAVE POWER AT OPTICAL WAVELENGTHS Interim Engineering Report No. 3, for the Period 1 November 1962 through 31 January 1963**

S. E. Sobottka [1963] 17 p
(Contract AF 33(616)-8986)
(W-J-63-606R12)

Two gridded two-region laser tubes have been fabricated and operated. The first tube was short-lived because of imperfections in the grid, the second one is presently the subject of study. Some single-pass gain measurements have been made on the second tube, with positive gain having been observed in the discharge region outside the grid, but no gain as yet having been measured inside the grid. More RF excitation power will be necessary for further measurements, and extensive measurements of gain as functions of gas pressures must yet be made. Author

**N63-13820** Joint Publications Research Service, Washington, D.C.

**SOME PROBLEMS OF THE INTERACTION OF CHARGED PARTICLES WITH AN ELECTRIC FIELD**

G. M. Gershteyn Mar. 20, 1962 300 p 100 refs Transl. of the book "Nektoroye Vorposy Vzaimodeystviya Zaryazhennykh Chastits s Elektricheskim Polem", Saratov, 1960 p 1-165
(JPRS-13043) Distributed by OTS

The processes involved in the interaction between charged particles and alternating electric fields are described with sufficient simplicity and clarity to be of use to students and scientific workers interested in the processes that occur in generators, amplifiers, and accelerators. The areas covered include: charges and currents induced by moving charged particles; simulation of the electric field of vacuum devices; determination of induced currents by particle beams on equivalent circuits; interaction between particles and high-frequency fields in devices with static control and with dynamic control; space-charge waves; nonresonant oscillations of magnetrons. R.C.M.

**N63-13827** Joint Publications Research Service, Washington, D.C.
**CYBERNETIC ACCELERATOR**
A. Mints May 15, 1962 12 p Transl. of article from Izv. (Moscow), Apr. 24, 1962 p 6
(JPRS-13770) Distributed by OTS

The need for accelerators capable of producing beams with an energy of 1000 billion electron volts is discussed along with the possibility of obtaining these levels with automatic control systems. A control system concept is described which would permit an increase in accelerator output by a factor of 30 with only a slight increase in accelerator weight. R.C.M.

**N63-13830** Carnegie Inst. of Tech. Metals Research Lab., Pittsburgh, Pa.
**EVAPORATION OF SILVER CRYSTALS Final Report**
W. L. Winterbottom and J. P. Hirth Oct. 1, 1962 115 p 98 refs
(Contract Nonr-760(17))

The rates of free vaporization of single crystals of silver have been measured as a function of the crystallographic orientation of the vaporizing surface, the mode of surface preparation, the degree of contamination, and the temperature. The flux from the (111), (110), (100), and polycrystalline surfaces was continuously measured, and the concurrent morphological state of the surface was noted. The flux was measured throughout the period of vaporization by monitoring the fundamental frequency shift of an AT cut quartz oscillator positioned so as to intercept a known fraction of the flux from the vaporizing surface. The results indicate that the vaporization kinetics of single and polycrystalline surfaces with the degree of perfection corresponding to as-grown or annealed single crystals are essentially ideal and independent of the crystallographic orientation of the surface. Certain types of surface impurities are shown to markedly influence the kinetics of vaporization. Author

**N63-13851** Air Force Cambridge Research Labs. Electronics Research Directorate, Bedford, Mass.
**PARTIALLY COHERENT DIFFRACTION BY A CIRCULAR APERTURE Research Report**
R. A. Shore Aug. 1962 13 p 8 refs
(AFCRL-62-715)

Diffraction patterns of a circular aperture illuminated by partially coherent light can be calculated for a variety of correlation functions and radially varying intensities. The calculation is facilitated by using a theorem, based on the Wolf formulation of coherent theory, that relates the Fraunhofer intensity of a quasi-monochromatic spatially stationary source to the Fourier transform of the product of the source autocorrelation function and the normalized source mutual intensity. Curves are presented for the case of a circular aperture with uniform intensity and exponential correlation. Author

**N63-13855** Rensselaer Polytechnic Inst., Troy, N.Y.
**SUSTAINED OSCILLATION OF SYSTEMS WITH DRY FRICTION AND RAMP INPUT**
C. N. Shen and Hubert Wang Nov. 1, 1961 88 p 17 refs
(NASA Grant NsG-14-59)
(Mech. Engin. Rept. -ACI) OTS: $8.10 ph, $2.84 mf

This report deals with the undesirable sustained oscillation due to dry friction. A basic third-order type two system is studied, with particular emphasis on the analysis of the dry friction dynamics. The analytic solutions are obtained by an iteration method for their boundary values with the aid of a digital computer. The simulation of dry friction for an analog computer is achieved by the combination of hysteresis diagram and bridge-type limiters. The analytic solutions are compared with the analog computer solutions with good accuracy. The analog computer is also used to solve certain problems involving systems with load disturbance, dry friction reversals, and torque saturation. Further applications may be extended to autopilot and engine control systems. Author

**N63-13915** Aberdeen Proving Ground. Ballistic Research Labs., Md.
**THE SHOCK-INDUCED POLARIZATION OF DIELECTRICS**
F. E. Allison and A. B. Wenzel Dec. 1962 20 p 3 refs
(BRL MEMO-1449)

In previous experiments it was shown that a displacement current is generated in suitable dielectric materials subjected to explosively produced shock waves. A theoretical description of the shock-induced displacement current, which takes into account the electrical properties of the dielectric and the shock-propagation characteristics of the media, is used to interpret data obtained from experiments employing polystyrene as the dielectric. The theory predicts that the initial current is directly proportional to the area, inversely proportional to the thickness of the dielectric, and independent of the resistance, all of which agree with earlier experimental findings. The data show that most of the increase in the dielectric constant is due to an increase in the density of the specimen, with a rise in temperature playing a lesser role. Author

**N63-13916** Aeronautical Research Associates of Princeton, Inc. Princeton, N.J.
**ENERGY AND MOMENTUM EXCHANGE BETWEEN NON-EQUIPARTITION GASES**
T. F. Morse Charlottesville, Va. U. School of Engineering and Applied Science, Mar. 1963 38 p 23 refs Submitted for Publication
(Contract Nonr-3623(00); Proj. Squid)
(Tech. Rept. ARAP-5-P)

The energy and momentum relaxation of the components of a non-equipartition gas mixture is considered. For the case where each component of the mixture has a Maxwellian distribution at a temperature $T_i$, with the peculiar velocity in the Maxwellian measured relative to the species diffusion velocity, $\underline{V}_i$, and a "diffusion" Mach number not too large, the results have a particularly simple form. The calculations were carried out for the hard sphere, Coulomb, and Maxwell force laws of interaction. It is also noted how these results may be used to construct approximate kinetic model equations for the case of hard sphere and Coulomb interaction, in a manner similar to that proposed by Sirovich. Author

**N63-13920** Stanford Research Inst., Menlo Park, Calif.
**ENERGY EXCHANGE BETWEEN GASES AND SOLIDS**
Henry Wise Charlottesville, Va. U. School of Engineering and Applied Science Feb. 1963 12 p 27 refs Submitted for Publication
(Contract Nonr-3623(00); Proj. Squid)
(Tech. Rept. SRI-15-P)

The contribution of surface adsorption to the mechanism of heat transfer between a gas and a solid at low pressures is considered. The problem is treated as a rate process for the reaction of a gas molecule impinging on an adsorbing site on the surface. The impinging gas molecules may encounter a surface atom in either an elastic or inelastic collision. In an inelastic collision, the impinging gas molecule remains adsorbed on the surface long enough for an interchange of energy to occur. Accordingly, the temperature accommodation between a solid and a gas may be governed by the time lag between condensation and evaporation of the molecules at the surface; evaporation is dependent upon the adsorbed molecule acquiring the necessary configuration and activitation energy; and the probability that a molecule will gain or lose energy on striking a surface is given by the ratio of desorption of a gas at temperature $T_2$ to the total rate of impingement of gas molecules with initial temperature $T_1$. The fraction of the energy difference which the gas carries away on leaving the surface is given by the accommodation coefficient. The accommodation coefficient is derived for the mobile adsorbate-isothermal case and the mobile adsorbate-non-isothermal case. It is assumed that the residence time of the adsorbed

molecule is sufficient for complete thermal equilibrium, the reaction is independent of condensed molecules on neighboring surface sites, and reflected molecules which are not adsorbed exchange no energy with the surface. M.P.G.

**N63-13939** Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro
**EXCITED STATES IN $N^{14}$ FROM $C^{12}$+d REACTIONS**
G. S. Mani, F. Picard, A. Sadeghi (Centre d'Etudes Nucléaires de Saclay, France), and J. M. F. Jeronymo Aug. 29, 1962 14 p 9 refs
(Its Notas de Física, v. 10, no. 1)

Excited-state levels in $N^{14}$ from $C^{12}$ + d reactions are presented. The data are the results from a program aimed at obtaining the energy levels in $N^{14}$ from various possible reactions. A.R.B.

**N63-13941** Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro
**ON THE DECAY $\Sigma^\circ \rightarrow \Lambda^\circ + \gamma$ IN THE CHARGE-INDEPENDENT PION INTERACTION**
Prem P. Srivastava 1962 10 p 3 refs
(Its Notas de Física, vol. 10, no. 3)

$\Sigma^\circ \Lambda^\circ$ anomalous magnetic moment is calculated in the charge independent pion baryon interaction. The lifetime for the radiative decay $\Sigma^\circ \rightarrow \Lambda^\circ + \gamma$ is found to be $\sim 1.46 \times 10^{-18}$ S for the same $\Sigma^\circ \Lambda^\circ$ parity while it is $\sim 0.33 \times 10^{-18}$ S in the case of the opposite parity. Author

**N63-13942** Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro
**ANGULAR DISTRIBUTION IN $\pi \rightarrow \mu + \nu$ DECAY (PART II)**
E. Frota-Pessôa and N. Margem 1962 11 p 2 refs
(Its Notas de Física, vol. 10, no. 4)

A study of the angular distribution of 8.669$\mu$ mesons resulting from $\pi$ decay at rest in nuclear emulsion is made, using area scanning, looking for $\mu$ ends. The results give no backward-forward asymmetry, contrasting with other results obtained in the same plates with area scanning, looking for $\pi$-$\mu$ vertices. Thus the conclusion, previously established, that the backward-forward asymmetry was due to bias is enforced. Author

**N63-13943** Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro
**SUR LE RAYONNEMENT $\gamma$ EMIS AU COURS DE LA TRANSMUTATION. THORIUM 234 (URANIUM XI) $\rightarrow$ PROTACTINIUM 234 METASTABLE (URANIUM X2) [ON $\gamma$ RAY EMISSION IN THE COURSE OF TRANSMUTATION. THORIUM 234 (URANIUM X1) $\rightarrow$ PROTACTINIUM 234 METASTABLE (URANIUM X2)]**
Roger Foucher, Jean Mérinis, Manuel Valadares, and Alceu de Pinho 1962 9 p 6 refs In French
(Its Notas de Física, vol. 10, no. 5)

The spectra of electrons from the conversion of gamma rays emitted in the course of transmutation, Thorium$^{234}$ to Protactinium$^{234}$ metastable, was studied by magnetic spectrography at 180° . Three gamma rays were found to be emitted; their nature, polarity, and relative intensity is as follows: (1) the ray of intensity 29.88 Kev is an $E_2$; (2) a doublet consisting of an $E_1$ ray of 63.64 Kev, and a very weak ray of 63.21 Kev which is probably a mixture of $M_1$ and $E_2$; and (3) a doublet consisting of an $M_1$ ray, very intense in electrons of 93.08 Kev, and a very weak ray of 93.52 Kev which is probably an $E_1$. Trans. by M.P.G.

**N63-13944** Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro
**LE SCHEMA DE NIVEAUX DU$^{234}$ Pa[THE SCHEMA OF THE LEVELS OF $^{234}$Pa]**
R. Foucher, M. Valadares, J. Mérinis, and Alceu de Pinho 1962 12 p 8 refs In French
(Its Notas de Física, vol. 10, no. 6)

The structural formula of protactinium-234 is examined because of recent experimental results which present evidence of three new radiations. A.R.B.

**N63-13945** Centro Brasileiro de Pesquisas Físicas, Rio de Janeiro
**TRANSITIONS ELECTROMAGNETIQUES DANS LES NOYAUX IMPAIR-IMPAIRS DEFORMÉS [ELECTROMAGNETIC TRANSITIONS IN ODD-ODD DEFORMED NUCLEI]**
Alceu de Pinho (Lab. de Physique Nucléaire, Orsay, France) Oct. 10, 1962 11 p 6 refs In French Presented at the Acad. de Sciences, Paris
(Its Notas de Física, v. 10, no. 7)

A review is presented of the probabilities of reduced electromagnetic transitions in odd-odd deformed nuclei as calculated using Nilsson functions. Results of particular cases of reduced transitions are discussed. I.v.L.

**N63-13954** Hanford Atomic Products Operation, Richland, Wash.
**METALLURGY RESEARCH OPERATION [First Quarterly Progress Report, October, November, December, 1962]**
J. J. Cadwell, J. C. Tobin, I. D. Thomas, R. L. Dillon, and R. G. Wheeler Jan. 15, 1963 160 p 38 refs
(Contract AT(45-1)-1350)
(HW-76228) OTS: $2.75

Progress in metallurgy research operations is reported in the following areas: neutron damage to metals; swelling of irradiated fissionable materials; mechanical properties and irradiation effects of reactor metals; flux monitoring; chemical metallurgy; materials development for the Plutonium Recycle Test Reactor (PRTR); aluminum corrosion and alloy development; production reactor corrosion and coating studies; N-Reactor corrosion and hybriding studies; and engineering of materials for reactor gas loops and pressure tubes. M.P.G.

**N63-13955** Aerospace Corp., El Segundo, Calif.
**THE DYNAMIC STABILITY OF ELASTIC SYSTEMS, VOLUME II**
V. V. Bolotin Dec. 10, 1962 93 p 100 refs Transl. by V. I. Weingarten, K. N. Trirogoff, and K. D. Gallegos
(Contract AF 04(695)-169)
(SSD-TDR-62-154, Vol. II; TDR-169(3560-30) TR-2, Vol. II)

This is Volume II of four proposed volumes of the translation of V. V. Bolotin's book, "The Dynamic Stability of Elastic Systems." Volume II contains the translation of Chapter Three, Chapter Four, and Chapter Five. Nonlinear effects are discussed in Chapter Three. Free and forced vibrations of a nonlinear system are discussed in Chapter Four. Amplitudes of vibrations at the principal parametric resonance obtained by using nonlinear theory are discussed in Chapter Five. Author

**N63-13956** Aerospace Corp., El Segundo, Calif.
**THE DYNAMIC STABILITY OF ELASTIC SYSTEMS, VOLUME III**
V. V. Bolotin Feb. 1, 1963 96 p 115 refs Transl. by V. I. Weingarten, K. N. Trirogoff, and K. D. Gallegos
(Contract AF 04(695)-169)
(SSD-TDR-62-154, Vol. III; TDR-169(3560-30)TR-2, Vol. III)

This is Volume III of four proposed volumes of the translation of V. V. Bolotin's book, "The Dynamic Stability of Elastic Systems." Volume III contains the translation of Chapter Six, Chapter Seven, Chapter Eight and Chapter Nine. The following are discussed: nonsteady-state vibrations, secondary resonances, the interaction of forced and parametrically excited vibrations, and extension of the applicability of theory already presented. Author

**N63-13960** Florida U., Gainesville
**RESEARCH AND DEVELOPMENT ON INDUCTION HEATING METHODS OF SIMULATING AERODYNAMIC HEATING [Interim] Technical Documentary Report**
Robert A. Noble May 1962 186 p refs
(Contract AF 33(616)-5703)
(WADC-TR-59-523, Pt. III; AD-276-384)

A method of experimentally designing work coils for a given surface power density distribution by measuring the magnetic field

intensity is discussed. A series of tests are described which heated a wing leading-edge section. These tests simulated the expected surface power density distribution for a gliding reentry flight. The temperature was automatically controlled over a period of approximately 100 minutes and attained a maximum value of approximately 3000° F. Tests for the purpose of determining work-coil efficiencies are discussed. Three methods of measuring the power produced by induction heating are described. The fields produced by flat work coils are compared to theoretical calculations. Also included is a discussion of measuring work-coil impedances. Author

**N63-13976** Union Carbide Corp. Parma Research Lab., Ohio
**HIGH TEMPERATURE, STEADY-STATE CREEP RATE IN SINGLE-CRYSTAL MgO**
R. L. Cummerow Mar. 8, 1963 29 p 26 refs
(Contract DA-30-069-ORD-2787)
(C-13)

Steady-state, three-point bending deflection-rate measurements on single crystals MgO samples in the temperature range of 1450° to 1700° C show that creep is a thermally activated process without a unique activation energy. The measured energies range from 3.5 to about 7 ev. This range of energies can be explained in terms of self-diffusion data if it is assumed that the creep rate is limited by self-diffusion. Small deviations from stoichiometry are shown to be very important in controlling the creep rate as they are in all ionic or electron transport processes. Understanding and control of these deviations will be necessary to obtain a quantitative understanding of either steady-state creep or diffusion. Author

**N63-13977** Du Pont de Nemours (E. I.) and Co. Savannah River Lab., Aiken, S.C.
**RESONANCE INTEGRALS AND SELF-SHIELDING FACTORS FOR DETECTOR FOILS**
Norman P. Baumann Jan. 1963 54 p 34 refs
(Contract AT(07-2)-1)
(DP-817) OTS: $1.25

Effective activation resonance integrals for thin and thick foils in an isotropic neutron flux were measured by a cadmium ratio method. Gold was used as a standard. Values obtained for dilute resonance integrals in barns, not including 1/v capture, were: $Au^{197}$, 1390 ±40 (Reference); $U^{238}$ capture, 280 ±10; $Cu^{63}$, 3.17 ±0.18; $Cu^{65}$, 1.39 ±0.22; $Mo^{98}$, 9.9 ±1.1; $Mo^{100}$, 4.06 ±0.23; $W^{186}$, 476 ±50; and $Na^{23}$, 0.075 ±0.010. Dilute resonance integrals including 1/v capture above 0.60 ev were: $U^{235}$ fission, 263 ±9 and $In^{115}$, 3200 ±100. These resonance integrals and the measured resonance flux self-shielding factors were generally in good agreement with calculations. However, the two isotopes of molybdenum appeared to have major contributions to their resonance integrals from nontabulated resonances. Author

**N63-13992** University of Southern Calif., Los Angeles
**THE EXTERNAL FIELD PRODUCED BY AN ARBITRARY SLOT ON A DIELECTRIC COATED ELLIPTIC CYLINDER Technical Report**
Cavour W. H. Yeh Sept. 1962 37 p 16 refs
(Contract AF 19(604)-6195)
(USCEC-82-206; AFCRL-62-781; EE-16)

Expressions are derived for the external electromagnetic field produced by an arbitrary slot on the conducting surface of a dielectric coated elliptic cylinder of infinite length. It is assumed that the electric field tangential to the slot is a prescribed function. Boundary conditions are satisfied using the orthogonality characteristics of Mathieu functions. The integrals in the formal solution are evaluated by the saddle-point method for the far-zone fields. These far-zone-field solutions are then specialized to thin circumferential and axial slots. Illustrative numerical computations for the far-zone field of a thin axial slot are carried out. Author

**N63-13993** Joint Publications Research Service, Washington, D.C.
**SOVIET RESEARCH IN CYCLIC ACCELERATORS**
May 15, 1962 287 p 141 refs Transl. of two articles from Teoriya Uskoriteley. Fotoyadernyye Reaktsii (The Theory of Accelerators. Photonuclear Reaction) in Tr. Fiz. Inst., Acad. Nauk SSSR, Radioastron. (Moscow), v. 13, 1960 p 3-173
(JPRS-13752) Distributed by OTS

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**N63-13994** Joint Publications Research Service, Washington, D.C.
**RESEARCH IN THEORY OF MOVEMENT OF PARTICLES IN MODERN CYCLIC ACCELERATORS**
A. A. Kolomenskiy Transl. from Teoriya Uskoriteley. Fotoyadernyye Reaktsii (The Theory of Accelerators. Photonuclear Reaction) in Tr. Fiz. Inst., Akad. Nauk SSSR, Radioastron. (Moscow), v. 13 1960 p 3-129 *In its* Soviet Research in Cyclic Accelerators May 15, 1962 p 1-220 98 refs (See N63-13993 09-23)

Research on particle motion covered the following: betatron oscillations of particles in magnetic periodic systems; critical energy in a synchrophasotron; influence of radiation on the movement of electrons in cyclic accelerators; and particle motion in the phaseotron. R.C.M.

**N63-13995** Joint Publications Research Service, Washington, D.C.
**THEORETICAL ANALYSIS OF METHODS USED FOR INCREASING THE EFFECTIVENESS OF CYCLIC ACCELERATORS**
Ye. M. Moroz Transl. from Teoriya Uskoriteley. Fotoyadernyye Reaktsii (The Theory of Accelerators. Photonuclear Reaction) in Tr. Fiz. Inst., Akad. Nauk SSR, Radioastron. (Moscow), v. 13, 1960 p 130-173 *In its* Soviet Research in Cyclic Accelerators May 15, 1962 p 221-283 43 refs (See N63-13993 09-23)

Methods for increasing the effectiveness of cyclic accelerators are covered as follows: autophasing of accelerated particles; sectoral cyclotrons; and accelerators with stable contacting orbits. R.C.M.

**N63-13999** Michigan U. Plasma Engineering Lab., Ann Arbor
**DEVELOPMENTS IN INDUCTIVE ENERGY STORAGE APPARATUS AND INITIAL HIGH CURRENT, HIGH DENSITY ARC EXPERIMENTATION AND ANALYSIS [Final] Technical Documentary Report**
W. G. Dow, W. N. Lawrence, and I. W. Rozian Arnold Engineering Development Center, Mar. 1963 106 p 6 refs
(Contract AF 40(600)-934)
(Rept. 04807-13-F; AEDC-TDR-63-60)

This report is a summary of the final tasks that were required to bring a six-megajoule inductive-energy power supply to an operational stage and the initial phases of an experimental program in the scientific study of electric arcs in extremely dense air. Currents up to 100,000 amperes have been attained. Nitrogen at a density up to 100 times normal atmospheric density has been used as the medium for the arc. Author

**N63-14021** Bettis Atomic Power Lab., Westinghouse Electric Corp., Pittsburgh, Pa.
**DIFFERENTIAL THERMAL ANALYSIS OF SOME IRRADIATED MATERIALS**
R. M. Berman Feb. 1963 19 p 9 refs
(Contract AT-11-1-GEN-14)
(WAPD-TM-350) OTS: $0.50

Differential thermal analysis has been successfully applied to highly radioactive irradiated materials through use of a disposable sample holder and appropriate remotely operated equipment; measurement of the temperature at which radiation damage is annealed, as well as of the quantity of energy released, has been obtained. In the cases of irradiated, amorphous $U_3O_8$ and $Al_2O_3$, the energy release associated with the return of crystallinity was measured; results of the measurements indicate that these amorphous materials are supercooled liquids, that is, true glasses. Negative results were obtained on differential thermal analysis runs on $UO_2$ and $ZrO_2UO_2$.
Author

**N63-14022** Atomics International, Canoga Park, Calif.
**KINETICS, STABILITY, AND CONTROL. A SELECTED BIBLIOGRAPHY**
R. L. Johnson Mar. 15, 1963 43 p 548 refs
(Contract AT(11-1)-GEN-8)
(NAA-SR-7786) OTS: $1.00

This report is a bibliography of literature pertaining to nuclear reactor kinetics, control, and stability published prior to the autumn of 1962. The purpose of this bibliography is to provide a ready source of references by which analysis of the dynamic behavior of SNAP reactor systems can be planned, guided, and evaluated. As a result, the emphasis is on theory and calculation. Author

**N63-14030** General Motors Corp. Defense Research Labs., Santa Barbara, Calif.
**RADIATION FROM NON-EQUILIBRIUM, MOLECULAR GASES Technical Report**
C. F. Hansen Dec. 1962 42 p
(Contract DA-04-495-ORD-3567; ARPA Order 347-62; Proj. Defender)
(TR62-209A)

Solutions to the radiative transfer equation in a nonequilibrium gas are derived in a form paralleling the usual equilibrium solutions. These nonequilibrium solutions are given in terms of an effective absorption coefficient and a Planck-like energy distribution, both of which are expressed as functions of an effective electronic excitation temperature and relative oscillator-strength distributions across the spectrum. Approximate oscillator-strength distributions which are functions of vibrational temperature only, and which give the profile of the band produced by a given electronic transition, are presented. Example calculations are made at vibrational temperatures of 1000°, 3000°, and 10,000° K for the strong molecular bands in nitrogen; namely, the $N_2$ first- and second-positive and the $N_2^+$ first-negative bands. Author

**N63-14043** Aerospace Corp., El Segundo, Calif.
**THE DYNAMIC STABILITY OF ELASTIC SYSTEMS, VOLUME I**
V. V. Bolotin Nov. 1, 1962 70 p 80 refs Transl. from Russian by V. I. Weingarten, K. N. Trirogoff, and K. D. Gallegos
(Contract AF 04(695)-169)
(TDR-169(3560-30)TR-2, Vol. I; SSD-TDR-62-154, Vol. I)

Volume I contains the introduction and the first two chapters of V. V. Bolotin's book, "The Dynamic Stability of Elastic Systems." This work is essentially a systematic exposition of questions in the theory of the dynamic stability of elastic systems. The introduction contains a short history of the development of the subject. Methods for the determination of the boundaries of the regions of dynamic instability are examined. The effect of damping on the regions of dynamic instability is investigated. The results from experimental investigations and an extensive bibliography are also included. Author

**N63-14048** Bolt Beranek and Newman, Inc., Cambridge, Mass.
**RADIATION EFFICIENCY OF PANELS**
Gideon Maidanik [1963] Repr. from J. Acoust. Soc. Am., v. 35, no. 1, Jan. 1963 p 115 2 refs
(NASA Contract NASr-47)

Laboratory and field measurements of the radiation efficiency of construction boards and concrete panels have been carried out by Kihlman. Theoretical expressions for the radiation efficiency of panels were derived recently by Maidanik. These expressions are applicable to some of the structures that were used by Kihlman in his experiments. Comparison between the theory and the experimental results is made. Author

**N63-14049** Servomechanisms, Inc. Research and Development Center, Goleta, Calif.
**ARMY/NAVY INSTRUMENTATION PROGRAM: PHOSPHOR RESEARCH Final Report**
E. J. Soxman Dec. 1962 56 p 10 refs
(Contract Nonr-1076(00))
(SMIR-62-7)

A research program was carried out involving a study of thin film electroluminescent cells. These cells were produced on glass substrates. They employed transparent $SnO_2$ for one electrode and aluminum for the other. By a detailed study of the variables involved in the vapor deposition process, a simple, one-step, reproducible procedure was established for the preparation of ZnS:Mn phosphor films. This procedure is unique in not requiring excessively high temperatures or any succeeding heat treatment. Through considerable advancement in the control of the deposition and substrate preparation, it was possible to fabricate numerous arrays of small cells, each approximately 0.025 in. × 0.025 in. square. Smaller cells leading to an even higher density display or ELPC configuration are now feasible. In contrast to other published results in thin film ZnS-type phosphors, a strong correlation was found between efficient electroluminescence and the development of a well crystallized, highly oriented film structure consisting of the cubic form of ZnS. The rate of change of light output of these cells per incremental change in applied voltage was observed to be significantly greater than that for a common commercial electroluminescent cell. Exceptionally high dielectric strength (2500 volts/mil) and effective dielectric constant (50 to 70) were exhibited by cells which included an additional dielectric film of $GeO_2$. Author

**N63-14050** . Servomechanisms, Inc. Research and Development Center, Goleta, Calif.
**HOLLOW CRYSTALS OF HEXAGONAL ZnS**
E. J. Soxman *In its* Army/Navy Instrumentation Program: Phosphor Research Final Report Dec. 1962 p 41-49 12 refs Submitted for Publication (See N63-14049 09-23)
(Sponsored by Army-Navy Instrumentation Program)
(SMIR-62-7, Appendix)

Zinc sulfide powder was heated in a double-crucible arrangement at 1150° C for one to three hours. X-ray diffraction measurements showed the development of hexagonal sulfide (wurtzite) and some oxide (zincite). On a thin platinum ribbon, introduced to aid the study of crystal growth, several well-developed hollow crystals were found. By transmission electron-diffraction measurement, these unusual crystals were identified as hexagonal zinc sulfide. Author

**N63-14054** Louisiana State U. and Agricultural and Mechanical Coll., Baton Rouge
**EFFECT OF PRESSURE ON THE OSCILLATION'S PERIOD IN THE ETTINGSHAUSEN-NERNST EFFECT IN ZINC AT HELIUM TEMPERATURE Interim Technical Report No. 3**
R. J. Deck, C. G. Grenier, and J. M. Reynolds Jan. 1963 69 p 26 refs
(Grant DA-ORD-31-124-61-G76)
(AROD-1579-10)

A piston and cylinder combination using solid hydrogen as a pressure transmitting medium was constructed for the purpose of studying pressure dependence of the Ettingshausen-Nernst effect and the thermoelectric power in zinc. The apparatus was designed

to produce a maximum of 5,000 atmospheres of hydrostatic pressure at helium temperatures in a .25-inch-diameter cylinder. The technique involved was that originally pioneered by Stewart and Swenson. Author

**N63-14060** Rochester U., N.Y.
**PRINCIPLES OF CLASSICAL DYNAMICS**
N. Mukunda ed. Jan. 23, 1963 249 p 26 refs (Lectures by E. C. G. Sudarshan)
(Contract AT(30-1)-875)
(NYO-10250)

A review of classical dynamics includes: Newtonian mechanics; generalized coordinates and Lagrange's equations; Hamilton's principle; Schwinger-Weiss action principle—Lagrangian form; Schwinger-Weiss principle—Hamiltonian form; relation between Langrangian and Hamiltonian systems; degenerate cases; Poissons brackets; canonical transformations; canonical transformations—degenerate cases; Lagrange brackets; properties of Poisson brackets; group-theoretic properties of canonical transformations; sets, groups, rings, algebras; local Lie groups; Lie algebras; realizations of algebras and groups; Schroedinger, Heisenberg, and interaction pictures; translation group in three dimensions; three-dimensional rotation group; the pure spin system—torque-free precession; tensors and spinors; the Euclidean group; the Galilei group; the Lorentz group; space-time inversions; many-particle systems; relativistic invariance in canonical mechanics; relativistic kinematics; and noninertial frames. I.v.L.

**N63-14061** France. Ministère de l'Air, Paris
**SUR L'EMPLOI DU COURANT ALTERNATIF A L'ÉTUDE DE LA DÉCHARGE POLAROGRAPHIQUE [ON THE USE OF ALTERNATING CURRENT IN THE STUDY OF POLAROGRAPHIC DISCHARGE]**
Loïk Viet Paris, Service de Documentation et d'Information Technique de l'Aéronautique (SDIT), [Jan.] 1963 94 p 78 refs In French
(*Its* Publications Scientifiques et Techniques, N.T.-121) Available from SDIT, 2, Ave. de la Porte d'Issy, Paris (15e)

The use of an alternating current for studying polarographic discharge is examined as a contribution to the study of the speed of electrode reactions. The Faraday impedance of the discharge (where the input of ions is due only to diffusion) is determined for a mercury drop electrode and for a rotating platinum electrode. The role of (1) the kinetics of the reaction and of the diffusion, and (2) the frequency and amplitude of the alternating signal are established. The relationship between the Faraday capacity and the concentration of discharged ions is determined. Trans. by M.P.G.

**N63-14066** Wisconsin U. Theoretical Chemistry Inst., Madison
**THE HYPERVIRIAL THEOREM FOR COLLISIONS BETWEEN ELECTRONS AND ATOMS**
Michael B. Mc Elroy and Joseph O. Hirschfelder Mar. 8, 1963 20 p 10 refs Submitted for Publication
(NASA Grant NsG-275-62(4180); Contract AF 33(657)-7311)
(WIS-TCI-11, Ser. 3) OTS: $1.60 ph, $0.80 mf

The hypervirial theorem was first introduced for bound state systems and subsequently extended to one-electron scattering problems. In this paper electron-atom collisions are considered, and the appropriate form of the hypervirial theorem is derived. Its relation to the original formulation is discussed. Application is made to the electron hydrogen problem. Both elastic and inelastic collisions are investigated. Author

**N63-14075** Stanford Research Inst., Menlo Park, Calif.
**ATOMIC AND MOLECULAR CHARGE-TRANSFER PROCESSES Final Report**
Donald C. Lorents and Otto Heinz Feb. 18, 1963 14 p 3 refs
(Contract DA-04-200-ORD-1240)
(AROD-3251-1)

The differential cross sections for single electron charge transfer are being studied at primary ion energies below 1 Kev under conditions where the initial and final electronic states of the system can be defined. The kinetic energy $E_2$ of the secondary ion ejected when an ion interacts with a neutral particle in a charge transfer collision is dependent upon the angle of ejection $\theta_2$ as well as on the difference in binding energy between the final and initial state of the transferred electron $\Delta E$. Therefore, a series of curves of $E_2(\theta_2)$ were computed for each of the reactions under experimental consideration at several incident energies. A computer code was devised for these calculations, and a set of $E_2(\theta_2)$ curves for the $Ne^+ + Ar$ reaction at 200 ev is presented. The experimental program will be carried out in a 24-in.-diameter bakeable scattering chamber with a simple, electron-bombardment ion-source. M.P.G.

**N63-14079** California U., Berkeley. Lawrence Radiation Lab.
**ARGON-HELIUM SCINTILLATION**
Theodore Jenkins and Roger Wallace Oct. 24, 1962 37 p 7 refs
(Contract W-7405-eng-48)
(UCRL-10523) OTS: $1.00

The scintillation of liquid argon and gaseous helium has been investigated. Precise temperature control and care in purification were required. Alpha and gamma sources were used. A variety of mixture ratios of argon and helium were tried. The scintillators were found to be insensitive to gamma rays relative to alphas. Scintillations were not detected in liquid argon but only in the gas. Neutron $4\pi$ spectroscopy with these scintillating gases is discussed. Author

**N63-14080** California U., Berkeley. Lawrence Radiation Lab.
**PHYSICS DIVISION SEMIANNUAL REPORT, MAY 1962 THROUGH OCTOBER 1962**
Luis W. Alvarez et al Nov. 28, 1962 124 p refs
(Contract W-7405-eng-48)
(UCRL-10572) OTS: $2.50

A summary of general physics research is presented that included: bubble chambers; strange particle, pion, and heavy ion research; S-matrix and elementary particle theory; particle orbit theory; atomic beams; $K^+$ decay; mesic X-ray studies; beta decay of hyperons; scattering; FOG-CLOUDY-CLEAR computer program; an automatic scanning program; and accelerator operation and development. A.R.B.

**N63-14082** California U., Berkeley. Lawrence Radiation Lab.
**MECHANISM OF LIQUID-LIQUID SETTLING**
Albert D. Epstein and C. R. Wilke Jan. 14, 1963 52 p 18 refs
(Contract W-7405-eng-48)
(UCRL-10625) OTS: $1.00

The separation of two immiscible liquids in a gravity settler was studied in a program to learn more about the mechanism of the settling process. The liquids used were water and Aroclor 1248 (sp gr 1.36). A mixture of the two liquids was fed into one end of a long horizontal tank in which the two phases were separated by gravity and were drawn off at the top and bottom of the opposite end. The liquids were introduced through a pipe narrow enough to assure a high degree of turbulent mixing. The effectiveness of the settling process was determined by measuring the concentration of water in the aroclor phase resulting from (a) water dispersed during the initial mixing of the two phases and (b) water showered down into the Aroclor during the coalescence of the droplets into their respective phases from an emulsion layer at the settler interface. This emulsion layer moved toward the settler outlet at two to three times the velocity of the Aroclor phase. For the system investigated, the depth and length of the emulsion layer were found to depend upon the Reynolds number in the mixing section. The settler flow patterns were also drawn for the cases in which the emulsion layer ended in the settler and those in which it extended the entire length of the section. Author

**N63-14083** California U., Berkeley. Lawrence Radiation Lab.
**THE INFLUENCE OF HIGH PRESSURES ON THE MÖSSBAUER EFFECT IN DYSPROSIUM-161**
John A. Stone Jan. 17, 1963 74 p 64 refs
(Contract W-7405-eng-48)
(UCRL-10630) OTS: $1.75

Nuclear resonance absorption of the 25.6-Kev gamma ray of $Dy^{161}$ has been studied experimentally at pressures up to 100 kbar by using sources situated in gadolinium metal, together with thin metallic dysprosium absorbers. Velocity spectra taken at 30 and 50 kbar show complex hyperfine structure. Increasing the pressure leads to both greater recoil-free fractions and greater overall hyperfine splitting. The effect of pressure on the recoil-free fraction is satisfactorily explained with a modification of Hanks' theoretical treatment. It is proposed that the hyperfine splitting is predominantly due to electric quadrupole interactions, with the electric field gradient at the nucleus increasing with increasing pressure. By fitting theoretical spectra to the velocity spectrum at 30 kbar, a value of 1.30 is derived for the ratio of the quadrupole moments of the 25.6-Kev state and the ground state of $Dy^{161}$. Author

**N63-14084** Feltman Research Labs., Picatinny Arsenal, Dover, N.J.
**PROBABILITIES OF OPTICAL TRANSITIONS FOR ATOMS AND DIATOMIC MOLECULES**
V. N. Kolesnikov and L. V. Leskov June 1962 60 p 370 refs
Transl. by JPRS from Usp. Fiz. Nauk. (Moscow), v. 65, 1958 p 3-38
(AD-278-085; FRL-TN-137)

This is a literature review of both theoretical and experimental papers which have appeared since 1930, on the determination of the probabilities of optical transitions in atoms and electron-vibration transitions in diatomic molecules. Author

**N63-14085** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena
**ATOM CONCENTRATION MEASUREMENTS USING ELECTRON PARAMAGNETIC RESONANCE**
A. F. Hildebrandt, C. A. Barth, and F. B. Booth Repr. from Phys. Chem. Aerodyn. Space Flight (Gt. Brit.) p 194-203 11 refs
(Contract DA-04-495-ORD-18)

Atom concentration measurements were made of $N(^4S)$ and $H(^2S)$ produced by microwave discharges in gaseous $N_2$ and $H_2$. Spectrometer drifts and fluctuations were corrected by calibrating with the high field spectrum of $O_2$ at 1 mm Hg pressure. Atom surface recombination was prevented by conditioning the quartz tube with nitrogen atoms until the afterglow was plainly visible. Absolute comparisons were made with the intensity of a paramagnetic salt and with gas phase titrations. The EPR reproducibility is ±5 percent or better, whereas the absolute measurements are ±25 percent or better. The variation of atom density and concentration with pressure of each atomic species is given. Author

**N63-14094** Uppsala U. (Sweden)
**ANALYSIS OF THE VARIATIONS OF THE MAGNETIC FIELD OF LIGHTNING DISCHARGES AND VARIATIONS OF THE ELECTROMAGNETIC FIELD AT DISTANCES FROM LIGHTNING DISCHARGES Second Summary Report, 1 April 1961-30 June 1962**
Harold Norinder July 31, 1962 6 p
(Contract AF 61(052)-171, S/A nos. 1, 2, 3, 4, and 5)
(AFCRL-62-786)

Magnetic field variations in the vicinity of lightning discharges and the directional properties of VLF waves propagated from lightning discharges were investigated. A harmonic analysis of the superimposed rapid variations occurring in the magnetic field was conducted, and the current values of vertical lightning discharges in the vicinity regions of the channels were calculated from oscillograph recordings. A two-station system was set up to study the electromagnetic field variations; these variations were found to be influenced by a radiation effect from the lightning channels. A frequency analysis of simultaneous records from the two stations is currently being conducted. M.P.G.

**N63-14105** Mitsubishi Electric Mfg. Co., Ltd. Research Lab., Amagasaki (Japan)
**CALCULATION OF TRANSIENT VOLTAGE AND CURRENT IN POWER SYSTEMS. PART II. AN APPROXIMATE CALCULATION**
Jun-ichi Baba and Toshihira Shibataki *In its* Mitsubishi Denki Laboratory Report, Vol. 4, No. 1 Jan. 1963 p 1-13 1 ref (See N63-14104 09-01)

It has been shown in Part 1 of this series that the transient phenomena in power systems should be conveniently calculated by using the concepts on traveling-wave theory. But the calculation procedure can be more simplified by approximating the lumped elements by distributed elements. This paper describes the method of obtaining the approximate distributed circuits of lumped elements and discusses the errors caused by the approximation. Author

**N63-14111** Mitsubishi Electric Mfg. Co., Ltd. Research Lab., Amagasaki (Japan)
**ELECTROLUMINESCENSE OF CADMIUM SULFIDE SINGLE CRYSTALS**
Hirosuke Yamashita, Sumiaki Ibuki, and Hiroyoshi Komiya *In its* Mitsubishi Denki Laboratory Reports, Vol. 4, No. 1 Jan. 1963 p 117-138 9 refs (See N63-14104 09-01)

In the electroluminescence of cadmium sulfide single crystals, the d.c. pulse and alternative current-voltage characteristics, the emission generated by the above three types of the current, the electric potential distribution, the temperature dependence of the edge, and green and orange emissions were observed. The electroluminescence induced by the pulse current showed the delay of about 200 μs at the rise, and the decay time of about 30 μs at the fall of the current. The temperature dependence of the wavelength in the edge emission peak follows the relation $\lambda_1 = 0.488 + 0.00014T$ (μ). The green (at about 530 mμ) and the orange (at about 600 mμ) emissions showed little change in the wavelength of their peaks in the range from the liquid nitrogen to the room temperature. From the results of the measurement of the current-voltage characteristics, it is presumed that the electronic avalanche is dominant in the electric-conduction mechanism. Author

**N63-14189** General Dynamics Corp. General Atomic Div., San Diego, Calif.
**DIFFERENTIAL NEUTRON THERMALIZATION Annual Summary Report, Oct. 1, 1961 through Sept. 30, 1962**
W. L. Whittemore AEC Div. of Tech Inform., Nov. 28, 1962 67 p 11 refs
(Contract AT(04-3)-167)
(GA-3409) OTS: $1.50

A large-aperture, rotating, mechanical chopper was constructed and used in conjunction with the pulsed linear accelerator as a velocity selector. Many features of this velocity selector are discussed in detail. The velocity selector is currently being used to study neutron inelastic scattering and the scattering kernel for a number of useful moderators. A series of measurements is reported for liquid hydrogen from which the conclusion is reached that liquid hydrogen behaves mostly as a "perfect" gas, with some effects due specifically to the liquid state. Preliminary measurements on polyethylene have shown significant details which are different from those predicted from the scattering theory of Goldman. The major difference between theory and experiment occurs at the lowest incident neutron energies where it is expected that the Goldman theory of polyethylene scattering would fail to represent adequately the exact molecular dynamics. Author

**N63-14205** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

**THERMOLUMINESCENT SPECTRA OF SODIUM CHLORIDE AND HYDROXIDE-FREE SODIUM CHLORIDE IRRADIATED WITH 40-MEV ALPHA PARTICLES**

James A. Partridge Washington, NASA, Apr. 1963 16 p 15 refs
(NASA TN D-1662) OTS: $0.50

The thermoluminescent spectra of 40-Mev alpha-irradiated sodium chloride single crystals have been investigated through post-irradiation measurements. Both as-received and hydroxide-free sodium chloride were used. Graphs of the variation of emission band intensity and position as a function of temperature for various radiation fluxes are presented. Emission bands at 360 and 432 millimicrons were found in both crystal types; a new band at 572 millimicrons was also observed in the hydroxide-free crystals. The 432-millimicron band is suppressed in the high-temperature glows of the hydroxide-free crystals. In contrast to X-ray induced spectra, the effect of particle irradiation was to cause the 360- and 432-millimicron bands to appear together in the high-temperature glow peaks. Comparison of the glow curves of the two crystal types indicated that the hydroxide-free sodium chloride increased light output. An impurity or defect is thought to be responsible for the effects noted in the hydroxide-free crystals. Author

**N63-14215** Rochester U., N. Y.

**THE NATURE OF THE AXIOMS OF RELATIVISTIC QUANTUM FIELD THEORY II**

E. C. G. Sudarshan Feb. 15, 1963 31 p 17 refs Submitted for Publication
(Contract AT(30-1)-875)
(NYO-10258)

This paper continues the study of the nature and interdependence of the axioms of relativistic field theory; attention is focused on the notion of relativistic invariance. The central result of the present paper is the derivation of necessary and sufficient conditions for a representation of the covariant free field to admit a unitary representation of the inhomogeneous Lorentz group associated with the field operator. It is shown that only the standard Fock-Cook representation has this property. The relevance of the requirement that the Lorentz group is represented by a unitary family associated with the field operator is exhibited by an analysis of the covariant representations of Segal and Shale. These representations involve extremal states which are not pure and group representations by intertwining operators. Author

# 24 PHYSICS, PLASMA

Includes: fusion; and magnetohydrodynamics.

*For related information see:* 05 Astronomy and Astrophysics; 23 Physics, General; and 25 Physics, Solid-State.

**N63-13817** Rome Air Development Center Electronic Warfare Lab., Griffiss AFB, N.Y.

**TEMPORAL PROFILES OF CONDUCTIVITY IN THE ELECTRIC SHOCK TUBE**

Thaddeus Baynard Welch, Jr. Jan. 1963 33 p 7 refs
(RADC-TDR-63-18)

Measurements were made in helium and argon gases between 1 and 5 millimeters of mercury pressure using microwave frequencies between 35.8 and 37.9 kmc. Shock fronts and contact surfaces were identified, and velocities of each were computed. Plasma profiles were computed using voltage and pressure as parameter. Results indicated that shock fronts were weakly ionized and the following contact surfaces were highly ionized. Conditions leading to the virtually complete removal of mass from the driver section of the shock tube were discovered and listed. Author

**N63-13824** General Electric Co. Space Sciences Lab., King of Prussia, Pa.

**INVESTIGATION OF NON-THERMAL IONIZATION FOR MHD ENERGY CONVERSION First Quarterly Report, Mar. 15, 1962 to June 15, 1962**

George W. Sutton [1962] 6 p 1 ref
(Contract AF 33(657)-8298)

The general purpose of this research is to explore the theoretical prediction that, in monatomic gases, magnetically induced ionization can increase the electron density to the point where the gases are sufficiently electrically conducting to be used in a magneto-hydrodynamic generator, for closed cycle operation with a nuclear heat exchanger. The practical application of this theory may be for space vehicle power wherein the minimization of radiator area requires higher working fluid temperatures than are compatible with turbine stresses. Discussions in the following areas are presented: (1) a comparison between the Rankine and Brayton cycles; (2) diode tubes for obtaining data on nonequilibrium ionization in mixtures of gases and cesium vapor; (3) magnetically induced ionization in argon-cesium mixtures at supersonic speeds and at temperatures up to 2000° C, in a magnetic field of 35 kilogauss; and (4) magnetically induced ionization in liquid metal vapors. I.v.L.

**N63-13853** University of Southern Calif. Engineering Center, Los Angeles

**EXCITATION OF WAVES IN A WARM PLASMA BY AN ELECTRIC DIPOLE Technical Report**

Hans H. Kuehl Sept. 1962 33 p 12 refs
(Contract AF 19(604)-6195)
(USCEC-82-205; EE-15; AFCRL 62-737)

The general expression for the monochromatic electromagnetic field due to an electric dipole immersed in an unbounded, homogeneous, warm, collisionless plasma in the absence of a magnetostatic field is derived. A hydrodynamic description is used, and the limitations of this approach as applied to the problem are considered. It is found that the field is generally composed of three parts which, in the radiation region, correspond to the well-known transverse, longitudinal electron, and longitudinal ion waves. The power flow in the radiation region is shown to be largest along the axis of the dipole for low frequencies, whereas the maximum occurs perpendicular to the dipole at high frequencies. Author

**N63-13929** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

**STABILITY OF A HETEROGENEOUS SHEAR LAYER IN A MAGNETIC FIELD**

J. Menkes Nov. 1962 Repr. from Phys. Fluids, v. 5, no. 11, Nov. 1962 p 1424-1427 5 refs
(NASA Contract NAS7-100)
(JPL-TR-32-86)

The stability of a horizontal, heterogeneous shear layer subjected to a vertical magnetic field of constant magnitude has been investigated. The stabilizing effect of the magnetic field is clearly demonstrated. The behavior of a medium with an exponential density distribution is considered in detail. Author

**N63-13963** United Aircraft Corp. Research Labs., East Hartford, Conn.

**RESEARCH ON THE OSCILLATING-ELECTRON PLASMA SOURCE [Final Technical Report, July 1, 1960-Aug. 31, 1962]**

Jack W. Davis, Albert W. Angelbeck, and Edward A. Pinsley Wright-Patterson AFB, Ohio, Aeronautical Research Labs., Dec. 1962 175 p 25 refs
(Contract AF 33(616)-7448)
(ARL-62-471)

The oscillating-electron plasma source was investigated both experimentally and analytically to determine its fundamental operating characteristics. Primary emphasis was placed on an investigation to determine the parameters that control axial potential gradients in the plasma source. It was found that potential gradients on the order of 100 volts/cm can be maintained over length scales of centimeters in the essentially neutral plasma within the source. A theoretical analysis has indicated these gradients are supported by a dynamical process associated with the presence of nonthermal electron-energy distributions and the tendency for the plasma to remain electrically neutral. Length scales predicted by theory were found to be in general agreement with those observed experimentally. The plasma source was found to operate in several different modes, including a fluctuating mode which appears to result from a pumping action of the source. Rotation of the plasma was observed. Investigations were also performed to determine the limits of operation, power dissipated at electrodes, and the energy distributions of ions accelerated from the source. The results of these investigations are discussed in terms of their pertinence to the development of the plasma source as a low-thrust space-propulsion device. Author

**N63-14040** Princeton U. Plasma Physics Lab., N.J.
**SEMIANNUAL REPORT COVERING THE PERIOD JULY 1, 1962-DECEMBER 31, 1962**
Mar. 13, 1963 233 p 119 refs
(Contract AT(30-1)-1238)
(MATT-Q-20)

Plasma research directed toward achieving hot confined plasmas and toward a basic knowledge in plasma physics is reported. The areas covered include: plasmas produced by ohmic heating in the Model C stellarator; plasma diffusion across a strong magnetic field with the Model C and the Etude stellarator; velocity and damping of ion acoustic waves; Marshall-type coaxial plasma guns and development of low-loss capacitors; and theoretical investigation of kinetic theory, stability, and the interaction between plasma and electromagnetic waves. R.C.M.

**N63-14089** Radio Corp. of America. RCA Labs., Princeton, N.J.
**CESIUM VAPOR CATHODE STUDY Tethnical Note No. 1**
A. L. Eichenbaum, F. Norman, W. N. Parker, and H. Sobol Princeton, N.J., David Sarnoff Research Center, Sept. 14, 1962 48 p 12 refs
(Contract AF 30(602)-2767)
(RADC-TDR-62-489)

Experimental and theoretical studies have been initiated on cesium plasma guns with the objective of obtaining beam-current densities of 100 A/cm$^2$. Problems of beam acceleration, cesium-vapor recirculation and r.f. breakdown are also being considered. Two plasma guns were designed to yield beams of 100 A/cm$^2$ density. A third tube has been designed which has means for: (1) beam acceleration to several kilovolts, (2) cesium recirculation, and (3) beam analysis. A theoretical study of the stability of a plasma synthesized within a hollow, infinitely long cylinder is being carried out. Author

**N63-14187** Air Force Cambridge Research Labs. Geophysics Research Directorate, Bedford, Mass.
**RESULTS FROM THE CONSERVATION LAWS FOR MAGNETOHYDRODYNAMIC FLOW Research Note**
G. L. Hand Dec. 1962 21 p 2 refs
(AFCRL-62-1112)

Equations similar to Bernoulli's equation are found for a conducting fluid with a superimposed magnetic field. These are obtained by considering the general statements of conservation of mass, momentum, and energy, and assigning special forms to the stress tensor and internal energy of the fluid. The conservation laws are combined with the appropriate Maxwell equations. By eliminating dissipation, simple results are found. The conservation laws and Maxwell equations are applied across a discontinuity to obtain hydromagnetic shock relations and fluid-vacuum interface conditions. Author

**N63-14193** General Motors Corp. Defense Research Labs., Santa Barbara, Calif.
**PLASMA FREQUENCY AND ELECTRON COLLISION FREQUENCY CHARTS FOR HYPERSONIC VEHICLE EQUILIBRIUM FLOW FIELDS IN AIR Technical Report**
Henry M. Musal, Jr. Dec. 1962 15 p 5 refs
(Contract DA-04-495-ORD-3567; ARPA Order 347-62; Proj. Defender)
(TR62-209C)

This report presents charts of plasma frequency and electron collision frequency as functions of air density (altitude) and vehicle velocity for selected regions of equilibrium hypersonic flow fields, along with a brief description of the method of derivation and the area of applicability. The two particular regions of the flow field treated here are the stagnation region and the end-point of the isentropic (expansion controlled) part of the wake of a blunt body. The charts cover the altitude range from zero to 350,000 feet and the velocity range from 6,000 to 40,000 feet/second. Author

**N63-14195** General Motors Corp. Defense Research Labs., Santa Barbara, Calif.
**IONIZATION IN HYPERSONIC WAKES: REVIEW OF MICROWAVE PROBE INSTRUMENTATION AND SUMMARY OF PRELIMINARY DATA Technical Report**
R. I. Primich and R. A. Hayami Dec. 1962 69 p 24 refs
(Contract DA-04-495-ORD-3567; ARPA Order 347-62; Proj. Defender)
(TR62-209D)

An outline is given of the progress which has been made in the development of the focused microwave probe as a plasma diagnostics tool and its application to the study of ionization in hypersonic wakes. Since a major part of the development has been concerned with instrumentation, the theoretical analysis of the interaction of the probe field with a plasma, data reduction, and interpretation of the results in terms of magnitudes and spatial variations of electron density and collision frequency, these topics are discussed in detail. Numerous results have been recorded and are now undergoing data reduction. Author

**N63-14196** General Motors Corp. Defense Research Labs., Santa Barbara, Calif.
**SCATTERING OF ELECTROMAGNETIC WAVES BY A PLASMA CYLINDER Technical Report**
J. A. Fejer Dec. 1962 27 p 14 refs
(Contract DA-04-495-ORD-3567; ARPA Order 347-62; Proj. Defender)
(TR62-209L)

The scattering of an electromagnetic wave by a plasma cylinder is investigated. The problem of the homogeneous cylinder is solved analytically. Numerical solutions are obtained for two selected examples in which the plasma is cylindrically symmetrical but inhomogeneous. In the calculations, the thermal motion of the electrons is taken into account approximately by a scalar pressure term. The results of the calculations show that resonant scattering takes place at several frequencies. At the lowest resonant frequency the thermal motion of the electrons plays little part, and the plasma behaves essentially as a dielectric. Thermal motion plays a prominent part in the resonances which occur at the higher frequencies and which are caused by standing "plasma waves" (electron acoustic waves). Results of the present analysis and numerical calculations show that these higher resonant frequencies are rather closely spaced (starting from just above the plasma frequency), if the plasma cylinder is homogeneous and its

diameter is much greater than the Debye length. The separation between the resonant frequencies increases, however, if the electron density is taken to be substantially greater on the axis of the cylinder than at the boundary. The results of the present computations for such an inhomogeneous cylinder appear to be in qualitative agreement with data obtained from experiments on the resonant scattering of microwaves by a gas discharge column. Author

**N63-14197** General Motors Corp. Defense Research Labs., Santa Barbara, Calif.

**THE INCIDENCE OF FOCUSED MICROWAVES UPON IONIZED DISTRIBUTIONS, PART 1. PLANE DISTRIBUTIONS Technical Report**

F. H. Northover Dec. 1962 24 p 2 refs

(Contract DA-04-495-ORD-3567; ARPA Order 347-62; Proj. Defender) (TR62-209N)

The effect of a plane slab of ionization located in the focal plane of a focused-lens transmission system is investigated. It is found that if the effective dielectric constant is close to unity (no loss) then the transmission through the slab is the same as if it were illuminated with a uniform plane wave. Author

# 25 PHYSICS, SOLID-STATE

Includes: semiconductor theory; and masers.

*For related information see:* 09 Electronics; 23 Physics, General; and 24 Physics, Plasma.

**N63-14063** France. Ministére de l'Air, Paris

**CONTRIBUTION A L'ÉTUDE DES PHÉNOMÈNES DE RECOMBINAISON ET DE DIFFUSION DANS LE SILICIUM [CONTRIBUTION TO THE STUDY OF RECOMBINATION AND DIFFUSION PHENOMENA IN SILICON]**

Andre Fortini Paris, Service de Documentation et d'Information Technique de l'Aéronautique (SDIT), [Jan.] 1963 56 p 20 refs In French

(Its Publications Scientifique et Techniques, N.T.-123) Available from SDIT, 2, Ave. de la Porte d'Issy, Paris (15e)

An investigation of the propagation of a wave of excitation in single silicon crystals, under various conditions of optical excitation, resulted in the discovery of two new propagation processes. These are: (1) propagation by luminescence; and (2) propagation by the diffusion of excitons. This discovery makes possible the differentiation between the effects of the usual mode of propagation, by the diffusion of free electrons, and propagation across a gap. I.v.L.

**N63-14209** Avco-Everett Research Lab., Everett, Mass.

**MEASUREMENT OF LOW RESISTANCE AND THE AC RESISTANCE OF SUPERCONDUCTORS**

Jacob L. Zar Jan. 1963 13 p 5 refs

(Contract AF 04(694)-33)

(BSD-TDR-63-60; AMP-100)

The resistance of highly conductive materials is measured by an induction method that does not require a direct electrical connection to the test specimen. Instead, the test sample is used as a short-circuited secondary winding of a transformer. The method is suited to specimens where lead correction errors would introduce difficulty, or where the temperature or field environment requires that the sample be located at some distance from the instruments. Resistances of the test specimen from $10^{-5}$ to $10^{-2}$ ohms are suitable for this method. It has been applied to determining the resistance of hard superconductors at 4.2° and at frequencies of 100 to 30,000 cps. Various niobium zirconium alloys followed a characteristic resistivity curve with $\rho$ proportional to $f^{-5}$ at high frequencies and $\rho$ proportional to $f^{1.7}$ at $f < 500$ c. Author

**N63-14216** Fundamental Methods Associates, Inc., New York, N.Y.

**FABRICATION OF SEMICONDUCTOR DEVICES BY NEUTRON TRANSMUTATION DOPING Annual Report, Dec. 1961-Dec. 1962**

Carl N. Klahr AEC Div. of Tech. Inform., Dec. 31, 1962 169 p 16 refs

(Contract AT(30-1)-2914)

(NYO-10088) OTS: $2.75

This is the first annual report on progress in the detailed development of fabrication methods for semiconductor devices by neutron transmutation doping. Quantitative expressions are given for spatial control of the electronically active impurities (introduced by neutron transmutation) by means of radiation dies. Neutron transmutation reactions in germanium and silicon have been surveyed. Required neutron-flux levels have been calculated. The electronic properties of devices produced by this method have been examined. The present program has been directed toward the design of a proof-of-principle experiment. The significant problems involved in these experiments have been wholly or partially resolved in the work accomplished to date. Author

**N63-14217** Advanced Kinetics, Costa Mesa, Calif.

**PRODUCTION OF MILLIMETER AND SUB-MILLIMETER ELECTROMAGNETIC WAVES BY THE INTERACTION OF PLASMA AND ELECTRON BEAMS WITH HIGH INTENSITY PULSED MAGNETS Eighth Quarterly Scientific Report [for] Period April 15-July 15, 1962 Final Report**

Ralph W. Waniek [1962] 57 p 11 refs

(Contract AF 19(604)-7406)

(AFCRL-62-718)

A summary is presented of the work performed to produce coherent millimeter and submillimeter electromagnetic radiation at high power levels by the deceleration of charged particles injected into strong magnetic fields. A paper by Malcolm A. MacLeod entitled "The Injection of High-Velocity Charged Particles into Strong Magnetic Fields," is included. This study is concerned with delineating approximate injection-parameter ranges which will allow the particles to attain the regions of high magnetic-field strength in a field whose axial variation is bell-shaped. The single-particle model is adopted, and the results of both qualitative and quantitative investigations are presented. R.C.M.

# 26 PROPELLANTS AND COMBUSTION

Includes: fuels; igniters; and oxidizers.

*For related information see:* 07 Chemistry; and 27 Propulsion.

**N63-13863** National Advisory Committee for Aeronautics. Lewis Flight Propulsion Lab., Cleveland, Ohio

**COMBUSTION PERFORMANCE OF TWO EXPERIMENTAL TURBOJET ANNULAR COMBUSTORS AT CONDITIONS SIMULATING HIGH-ALTITUDE SUPERSONIC FLIGHT**

Eugene V. Zettle, Carl T. Norgren, and Herman Mark Washington, NACA, Mar. 26, 1954 27 p 14 refs

(NACA RM E54A15) OTS: $2.60 ph, $1.01 mf (Declassified)

The performance of two experimental annular turbojet combustors was investigated at operating conditions typical of high-altitude supersonic flight. Each combustor consisted of a one-quarter sector of a single annular combustor designed to fit in a housing with an outside diameter of 25½ inches, an inside diameter of 10⅝ inches, and a combustor length of approximately 23 inches. Liquid fuel was injected into the combustion chamber from the upstream face of the combustor; in addition, a fuel-staging technique was investigated. Combustion efficiencies near 100 percent were achieved in both experimental combustors operating with combustor reference velocities of 200 feet per second and greater, at simulated supersonic flight conditions. These high efficiencies were maintained at the highest combustor-outlet temperatures investigated, namely, 1800° F for one combustor and 2000° F for the other. Reasonably flat outlet-temperature profiles were obtained and were considered satisfactory. The maximum total-pressure losses were 10.2 and 12.6 percent for the two combustors at a velocity of 165 feet per second and a temperature ratio of about 1.7. For combustor pressure losses of this magnitude, calculations indicated that the increase in engine specific-fuel consumption resulting from combustor pressure losses would be no greater in the engine for supersonic propulsion than in current turbojet engines. These pressure losses therefore appear acceptable for the supersonic flight conditions. Author

**N63-13876** National Advisory Committee for Aeronautics. Lewis Flight Propulsion Lab., Cleveland, Ohio

**EFFECT OF FUEL INJECTORS AND LINER DESIGN ON PERFORMANCE OF AN ANNULAR TURBOJET COMBUSTOR WITH VAPOR FUEL**

Carl T. Norgren and J. Howard Childs Washington, NACA, Apr. 6, 1953 47 p 3 refs
(NACA RM E53B04) OTS: $4.60 ph, $1.64 mf (Declassified)

A direct-connect duct investigation was conducted with one-quarter segment of a 25½-inch-diameter annular combustor which had been previously developed for liquid fuel injection. This combustor was modified by changing the fuel injectors and the liner design for vapor fuel injection. A total of 11 fuel-injection schemes and 2 liner air-entry hole patterns were investigated as well as a liner designed for low pressure drop. Values quoted subsequently for simulated flight performance refer to operation of the combustor in a typical 5.2 pressure ratio turbojet at a flight Mach number of 0.6. The combustor giving highest combustion efficiencies (model 14I) produced efficiencies above 98 percent at altitudes up to 61,000 feet at cruise (85 percent rated) engine speed. Increasing the airflow rate through this combustor to a value 69 percent above current design practice resulted in no appreciable effect on combustion efficiency at 56,000 feet at cruise speed. However, the outlet temperature profile for this combustor was unsatisfactory, and the pressure drop through the combustor was approximately twice as great as for many production-model combustors. The combustor designed for low pressure drop (model 15I) gave a pressure drop only 60 percent of that for model 14I, but the combustion efficiency of this combustor was low. The data indicate that combustion efficiency could be improved by a liner change to increase the amount of air entering the primary combustion zone. Author

**N63-13878** National Advisory Committee for Aeronautics. Lewis Flight Propulsion Lab., Cleveland, Ohio

**EFFECT OF DISSOCIATION ON EXHAUST-NOZZLE PERFORMANCE**

T. W. Reynolds Washington, NACA, June 11, 1958 26 p 22 refs
(NACA RM E58C25) OTS: $2.60 ph, $0.98 mf (Declassified)

Net jet-thrusts for stoichiometric hydrocarbon-air, hydrogen-air, and pentaborane-air mixtures are compared for equilibrium and frozen expansion in the exhaust nozzle at flight Mach numbers up to 10. Net jet-thrusts for equilibrium flow were three to five times that for frozen flow at Mach 10 for the three fuels cited, a hydrocarbon $(CH_2)_n$, hydrogen, and pentaborane. Examinations of the dissociation products involved and the energies associated with them, for the hydrocarbon- and hydrogen-air mixtures indicated that: a major portion of the dissociation energy for the hydrocarbon mixture is involved in the carbon monoxide molecule. Recent rate data indicate that this molecule would not be in equilibrium during the expansion process. These examinations also indicated that in the hydrogen-air mixtures, the dissociation energy is distributed in $H_2$, OH, H, and O. Recombinations of the H and O atoms and the OH radical probably follow equilibrium. It is uncertain whether $H_2$ reactions will follow an equilibrium or frozen path. Reactions involving NO decomposition will probably follow frozen flow. Fortunately, the amount of energy involved in the NO molecule is small for the cases examined. Author

**N63-13951** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

**EXPERIMENTAL EFFECT OF GAS FLOW TRANSIENTS ON THE HEAT RELEASE OF BURNING LIQUID DROPS IN A ROCKET COMBUSTOR**

Marcus F. Heidmann Washington, NASA, Mar. 1963 20 p 12 refs
(NASA TN D-1576) OTS: $0.50

The change in heat release caused by drop shattering was qualitatively evaluated in a small-scale rocket combustor. A single 0.089-inch-diameter liquid-heptane jet was reacted with uniformly distributed gaseous oxygen in a 2-inch-diameter cylindrical combustor. Gas-flow transients were imposed on the burning drops produced by the jet when orifice-type area restrictors were inserted in the gas-flow path. The arrangement of components was coaxial. Restrictor size and position were varied for various combustor pressure levels. Combustor performance with and without restrictors was compared to evaluate the effect of the flow transients. The experimental study consisted of two parts: (1) exploratory tests to determine the region of sensitivity of the burning drops to flow transients and (2) systematic variations to obtain correlating gas-flow parameters. The exploratory tests showed that, with near sonic flow at the restrictor, the transient caused approximately 55 percent of the heptane entering the restrictor region to vaporize and burn. The change in heat release was at a maximum immediately following the restrictor and was complete in less than 6 inches. Drop breakup or shattering was the apparent cause of the increase in heat release. The systematic variation of restrictor size and pressure level showed no critical condition that divided transients with and without an increase in heat release. Rather, heat release increased uniformly with an increase in the severity of the transient. A correlation of the experimental data on the basis of aerodynamic forces alone could not be obtained. Results showed an empirical correlation with gas momentum at the minimum area of the restrictor. Author

**N63-13983** Naval Ordnance Lab., White Oak, Md.

**SOLID-PROPELLANT ROCKET IGNITION SYSTEMS. IV. EVALUATION OF THE NOL "HI-LO" (ROCKET-IN-ROCKET) IGNITER**

Charles F. Sharn Jan. 1963 61 p 23 refs
(NOLTR-62-189)

A study is made of the performance of a small, monovent rocket ("Hi-Lo") used as an igniter in the NOL ignition research program. The theoretical and experimental methods used to predict the transient internal ballistics of the igniter and to define the physical-chemical and hydrodynamic characteristics of the igniter output are described. The output parameters evaluated are the rates and quantities of mass and thermal energy discharged from the igniter during a shot and the velocity and flame pattern of the vented igniter products. Emphasis is placed on the study of igniter performance resulting from the use of M2 igniter pellets (small cylinders of double-base composition). Author

**N63-14062** France. Ministère de l'Air, Paris

**ETUDE D'UN DISPOSITIF DE RÉGULATION AUTOMATIQUE DE LA STABILITÉ DE LA COMBUSTION [STUDY OF A DEVICE FOR AUTOMATIC REGULATION OF STABILITY OF COMBUSTION]**

Jean Salinié Paris, Service de Documentation et d'Information Technique de l'Aéronautique (SDIT), [Jan.] 1963 88 p 33 refs In French
(Its Publications Scientifiques et Techniques, N.T.-122) Available from SDIT, 2, Ave. de la Porte d'Issy, Paris (15e)

Experiments to accurately determine the amplitude of vibrations that accompany combustion in a burner of constant dimension are described. The amplitude of these vibrations (a function of the dilution and speed of air) is used as the controlling factor of a device that permits the combustion in the interior of the burner to be stabilized. Trans. by M.P.G.

**N63-14069** Bureau of Mines. Explosives Research Lab., Pittsburgh, Pa.

**INITIATION OF DETONATION RESULTING FROM COMBUSTION INSTABILITIES Quarterly Report, November 1, 1962 to January 31, 1963**

F. C. Gibson, R. W. Watson, G. R. Summers, and F. H. Scott Mar. 13, 1963 20 p 4 refs
(ARPA Order 44-62, Amend. 5)

Research performed in the field of initiation and growth of detonation in explosives and propellants is discussed. The prime area of interest involves the study of initiation mechanisms in an explosive system capable of undergoing either high-order detonation, or a low-velocity reaction, resulting from multiple low-amplitude shock which may occur in propellants because of combustion instability. Current emphasis is placed on the low-order regime. Experimental studies presented are directed toward a description of the initiation of detonation resulting from combustion instabilities in terms of the initial state of the explosive, the character of the initial stimulus, and subsequent interactions occurring in the system. I.v.L.

**N63-14098** Princeton U., N.J.

**RESEARCH ON SOLID PROPELLANT COMBUSTION INSTABILITY Technical Summary Report for the Period May 1, 1962 to November 30, 1962**

R. H. Woodward Waesche and Joseph Wenograd Jan. 29, 1963 17 p 10 refs
(Grant AF-AFOSR-62-460; ARPA Order 317-62, Amend. 1)
(Aeronautical Eng. Rept. 635a)

This report contains a summary of efforts to circumvent difficulties which have prevented the direct photographic or photometric observation of combustion processes occurring within an oscillating solid-propellant rocket. These difficulties have now been overcome by a suitable choice of propellant formulation. Also included are some calculations which relate to the direct measurement of temperature as a function of time within the burner. It was found that the addition of small amounts of sodium chloride will, under the conditions of the experiment, give rather broad wavelength bands with black-body emissivity. This will permit the use of a brightness technique for the measurement of temperature. Author

**N63-14221** Monsanto Research Corp. Boston Labs., Everett, Mass.

**RESEARCH ON SYNTHESIS OF NEW OXIDIZERS FOR SOLID PROPELLANTS Quarterly Technical Summary Report No. 2, October 1 to December 31, 1962**

James W. Dale, Henry P. Beltramini, Carl A. Olson, Stephen P. Terpko, and George A. Tsigdinos Feb. 26, 1963 20 p 19 refs
(Contract AF 04(611)-8520; ARPA Order 352-62)
(MRB-2022Q2)

The preparation and purification of various energetic oxidizing compounds required for miscibility and reactivity studies in liquid oxygen fluoride, and for conductimetric study of metathetic reactions involving the ions $ClF_2^+$ and $ClF_4^-$ in various inert solvents was investigated. Of the oxidizing compounds studied, $OF_2$, $ClF_3$, $N_2F_4$ and $ClO_3F$ were proved to be nonconducting; $ClF_3$, $N_2F_4$, and $ClO_3F$ were found to be unreactive towards $OF_2$. The binary system $ClF_3$–$ClO_3F$ was examined but no reaction was observed either in the gas or liquid phases; the ternary system $ClF_3$–$ClO_3F$–$OF_2$ behaved similarly. A.R.I.

# 27 PROPULSION

Includes: airbreathing, electric, liquid, nuclear, and solid propulsion.

*For related information see:* 04 Aircraft; 06 Auxiliary Systems; 26 Propellants and Combustion; and 30 Space Vehicles.

**N63-13887** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

**EVALUATION OF INJECTOR PRINCIPLES IN A 2400-POUND-THRUST ROCKET ENGINE USING LIQUID OXYGEN AND LIQUID AMMONIA**

Robert C. Hendricks, Robert C. Ehlers, and Robert W. Graham Washington, NASA, Jan. 1959 34 p 11 refs
(NASA MEMO 12-11-58E) OTS: $3.60 ph, $1.22 mf (Declassified)

The performances of three injector types were evaluated in a 2400-pound-thrust rocket test chamber to compare the relative effects of fuel and oxidant atomization. Injector 1 atomized the fuel and oxidant to a fine degree. Injector 2 atomized the fuel to a coarse degree with straight streams of oxidant. Injector 3 gave coarse oxidant atomization with straight streams of fuel. Each injector represents one of the eighteen such units forming the injector for a 50,000-pound-thrust rocket engine. Author

**N63-13905** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio

**A COLD-FLOW INVESTIGATION OF JET-INDUCED THRUST-VECTOR CONTROL**

John E. Mc Aulay and Albert J. Pavli Washington, NASA, Dec. 1960 45 p 1 ref
(NASA TM X-416) OTS: $4.60 ph, $1.55 mf (Declassified)

An experimental program has been conducted to investigate several methods of obtaining thrust-vector control by introducing a secondary gas into the primary-nozzle flow field. These methods were evaluated in a cold-flow rig using a bell-shaped nozzle having an expansion ratio of 7.27. The data were obtained over a range of secondary flows at or near the primary-nozzle design pressure ratio. The radial injection method produced a maximum amplification ratio of 1.3, using a single convergent port located at a primary-nozzle expansion ratio of about 6. Maximum amplification ratios between 2.3 and 2.9 were achieved with the counterstream injection method, depending on the position of the counterstream nozzle and on the secondary-flow ratio. (Amplification ratio is defined as the ratio of vector force to primary thrust divided by the ratio of secondary to primary flow.) Other methods, such as tangential, slanted-tube, and throat injection, gave relatively poor maximum amplification ratios (i.e., 0.8 or less). Author

**N63-13987** National Advisory Committee for Aeronautics. Lewis Flight Propulsion Lab., Cleveland, Ohio

**INVESTIGATION OF ADJUSTABLE SUPERSONIC INLET IN COMBINATION WITH J34 ENGINE UP TO MACH 2.0**

J. C. Nettles and L. A. Leissler Washington, NACA, Oct. 15, 1954 29 p 6 refs
(NACA RM E54H11) OTS: $2.60 ph, $1.07 mf (Declassified)

An annular nose inlet, equipped with a remotely controlled translating spike and variable bypass, was investigated in the Lewis 8- by 6-foot supersonic wind tunnel. The inlet performance was studied both with the airflow controlled by an operating J34 engine and with the engine simulated by a choked plug. The configuration was investigated at supersonic Mach numbers from 1.7 to 2.0, and at subsonic speeds of approximately Mach zero and 0.6. The results of the investigation indicated that with the engine operating at maximum rpm, the diffuser could be maintained critical by use of either the bypass or the translating-spike technique throughout the supersonic Mach number range investigated. With this particular design for spike translation, the inlet had high pressure recovery for all spike positions where the conical shock intercepts the cowl lip. The highest pressure recovery was observed for the condition where the oblique shock was the farthest ahead of the lip. In general, the engine exhibited a stabilizing influence on the inlet. The range of unstable operation and the observed intensity of pulsing were less with the actual engine than with the exit plug. The engine could be operated through certain zones of instability without difficulty, whereas with the choked exit, the amplitude of pulsing built up to a violent level when a traverse through the pulsing zone was attempted. Author

**N63-14007** Allegany Ballistics Lab., Hercules Powder Co., Cumberland, Md.

**HANDLING AND OPERATING INSTRUCTIONS FOR THE X248 ROCKET MOTOR**

Jan. 1963 51 p
(Contract NOrd-16640)
(ABL/M-105(Rev.))

The Rocket Motor X248 is a case bond, double base, solid-propellant system which utilizes reinforced plastic for all major components. This motor, as manufactured, has a propellant mass ratio of approximately 0.91 and delivers 116,500 lbf/-sec. of impulse when operating in vacuum. The original version of the X248, designated X248 A 2, was developed as the third-stage powerplant for the Vanguard Launching Vehicle. There have been nine models of the X248 motor developed, and they differ from the X248 A 2 motor primarily in the areas of attachment fittings and igniters. Models of the Rocket Motor X248 are used in the Thor-Able, Scout, Delta, Shotput, Javelin, Argo D4, Caleb, Transit-Tiros, and Atlas-Able vehicles. This manual gives brief description of the X248 models and the operating and handling instructions necessary for proper use of the motor. Author

**N63-14057** Western Electro-Acoustic Lab., Inc., Los Angeles, Calif.

**SUPPRESSION OF JET NOISE WITH EMPHASIS ON THE NEAR FIELD [Final] Technical Documentary Report [Dec. 1960–Jan. 1962]**

Kenneth M. Eldred, Robert W. White, Myron A. Mann, and Miltiades G. Cottis Wright-Patterson AFB, Ohio, Flight Dynamics Lab., Feb. 1963 275 p 8 refs
(Contract AF 33(616)-7772)
(ASD-TDR-62-578)

Methods are given for computing the acoustic power spectra generated by jets from coaxial turbofans, generalized mixing nozzles and ejectors; the aerodynamic performance gains or penalties associated with these various devices are compared. The results give the limits of acoustic power reduction which can be achieved by mixing nozzles. Further, the results show that major new reduction in jet noise can be obtained only with the development of new turbofan engines which have the maximum practical bypass ratios. These prediction methods for noise suppression in jet flows are based in part on derivations of the flow from axisymmetric and slot jets contained in the report. These flow derivations are based on the Prandtl mixing length concept and include an analysis of the mixing length determined from measured jet turbulence, and the interrelationship between flow Mach number, mixing length, and the resultant jet core length. Author

**N63-14122** General Dynamics/Astronautics, San Diego, Calif.

**EVALUATION TEST OF LIQUID OXYGEN PROPELLANT DUCT**

D. E. Lawrance Jan. 16, 1963 23 p 5 refs
(Rept. 55A-1354-4)

The main propellant line between a liquid-oxygen sump and a rocket engine was tested for leakage at cryogenic temperatures during vibration. The system consisted of a liquid-oxygen propellant duct, a liquid-oxygen recirculating line, a liquid-oxygen boost-pump sump, and associated hardware. Structural failure of the 55-02139-3 liquid-oxygen recirculation flex hose resulted in termination of the testing. M.P.G.

**N63-14191** Massachusetts Inst. of Tech. Aeroelastic and Structures Research Lab., Cambridge

**EXPERIMENTS ON JET FLOWS AND JET NOISE FAR FIELD SPECTRA AND DIRECTIVITY PATTERNS**

Erik Mollo-Christensen, Marc A. Kolpin, and John R. Martuccelli Feb. 1963 39 p 10 refs
(NASA Grant NsG-31-60)
(ASRL-TR-1007) OTS: $3.60 ph; $1.37 mf

The results of measurements of far-field sound emitted from jets are reported. The narrow-band power spectral density of the sound in the far field was measured for three jet diameters, three Mach numbers, and five angular positions. The intensity distribution of mean-square pressure fluctuation in the far field, in several wide frequency ranges, was also measured. The similarity relations found from the experiments are reported. Author

# 28 SPACE RADIATION

Includes: cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts.

*For related information see:* 05 Astronomy and Astrophysics; 16 Life Sciences; and 29 Space Sciences.

**N63-13823** Iowa State U., Iowa City

**SATELLITE OBSERVATIONS OF THE ARTIFICIAL RADIATION BELT OF JULY 1962**

H. A. Van Allen, L. A. Frank, and B. J. O'Brien Repr. from J. Geophys. Res., v. 68, no. 3, Feb. 1, 1963 p 619-627 17 refs
(NASA Grant NsG-233-62)

The earlier paper by O'Brien, Laughlin, and Van Allen on the earth's artificial radiation belt of July 1962 is reviewed and some additional data from Injun 1 on absolute intensities and time decay are given. The results and implications of this series of observations are shown to be in marked disagreement with the summary interpretation of Injun 1, Ariel, Traac, and Telstar data proposed by Hess and Nakada. New SUI observations by means of Explorer 14 in early October 1962 are reported and are found to be more or less consistent with the results of O'Brien, Laughlin, and Van Allen, but they can be reconciled with the interpretation of Hess and Nakada only by means of one or more heroic assumptions. Author

**N63-14179** Air Force Cambridge Research Labs. Geophysics Research Directorate, Bedford, Mass.

**A STUDY OF SACRAMENTO PEAK FLARES, IV: FILAMENT DISAPPEARANCES, FLARE SPRAYS, AND LOOP PROMINENCES**

H. J. Smith and W. D. Booton Oct. 1962 61 p

(GRD Res. Notes-58; AFCRL 472 (IV))

Sacramento Peak flare films provide nearly complete, continuous observational data for other forms of solar activity in addition to chromospheric flares. The character of the observations is optimum for flare detection and measurement, but for other phenomena the material is less satisfactory. The report tabulates and gives details of major occurrences in recent years of three types of events: (a) sudden disappearances, (b) flare sprays, and (c) coronal loops. Author

**N63-14188** Chicago U. Enrico Fermi Inst. for Nuclear Studies, Ill.

**RECENT INVESTIGATIONS OF THE LOW ENERGY COSMIC AND SOLAR PARTICLE RADIATIONS**

J. A. Simpson [1962] 29 p 20 refs Presented at the Conf. on Cosmic Rays in Interplanetary Space, Pontifical Acad. of Sci., Vatican City, Oct. 1962

(Contracts AF 49(638)-1008 and AF 19(604)-4554; Grant AF-AFOSR-62-23)

(EFINS-63-8)

The first part of this paper is a preliminary study of changes in intensity and spectrum of the solar-modulated cosmic radiation over a solar activity cycle. Neutron intensity monitors responsive to changes in primary particle magnetic rigidity as low as ~1 Gv have been analyzed for the period 1952 to 1962. It appears that the experimental results are to be explained by the growth and decay of a modulating electrodynamical region bounding a large volume of interplanetary space. The nonlinear growth and decay are functions of both solar activity and particle magnetic rigidity. The results suggest the buildup and subsequent relaxation of a heliocentric magnetic field modulating region which terminates in an interface with the stellar gas or galactic magnetic field. The second part is a report on recent experiments by Meyer and Vogt to study the origin of 80 to 350 Mev primary protons shown to be continuously present during years near maximum solar activity. The alternatives for their solar origin are discussed. Author

# 29 SPACE SCIENCES

Includes: space chemistry; cosmology; lunar and planetary exploration; and theoretical analysis of orbits and trajectories.

*For space biology see:* 16 Life Sciences.

*For related information see:* 05 Astronomy and Astrophysics; 12 Geophysics; and 22 Navigation and Guidance.

**N63-13843** Geophysics Corp. of America, Bedford, Mass.

**THE METEOROLOGY OF MARS AND VENUS Annual Technical Report**

George Ohring and Owen Cote' Jan. 1963 89 p 52 refs

(NASA Contract NASw-286)

(GCA-TR-63-6-N) OTS: $8.10 ph, $2.87 mf

The meteorology of Mars and Venus is studied with primary emphasis on the thermal structure and circulation processes of these two planetary atmospheres. Author

**N63-13845** Massachusetts Inst. of Tech. Research Lab. of Electronics, Cambridge

**MARINER -2 MICROWAVE OBSERVATIONS OF VENUS**

A. Edward Lilley (Harvard Coll. Observ.) and Alan H. Barrett [1963] 9 p Submitted for Publication

(NASA Grant NsG-250-62) OTS: $1.10 ph, $0.80 mf

Preliminary analyses of the Mariner-2 19-mm microwave observations of Venus are presented. During the 42 minutes of radio contact with Venus, the radiometer antenna scanned the planet's disk three times: the first scan crossed Venus' nightside, covering an arc of 10°; the second, in a 15° arc, crossed the terminator at a small angle and passed very close to the disk's center; and the third, 10° wide, crossed the sunlit side. The two scans near the limb of the planet recorded brightness temperatures significantly lower than the central scan. This limb darkening indicates radiation originating at the surface and attenuated near the limb by the atmosphere. The surface temperature of Venus, as derived from the recorded microwave brightness temperature, is approximately 700° K, which leads to a concept of Venus' surface as being extremely hot, dry, and hostile to terrestrial forms of life. M.P.G.

**N63-13952** Royal Aircraft Establishment, Farnborough (Gt. Brit.)

**MOTION OF SPACE VEHICLES IN THE SOLAR SYSTEM (OSOBENNOSTI DVIZHENIYA KOSMICHESKIKH APPARATOV V SOLNECHNOI SISTEME)**

S. G. Aleksandrov and R. E. Federov London, Ministry of Aviation, Dec. 1962 19 p Transl. by J. W. T. Palmer from Sovetski Sputniki i Kosmicheskie Korabli (Moscow), 1961

(RAE Library Translation 1019)

The concept of a sphere of influence is applied to flight to the Moon and planets. An optimum launch date exists, but reduction in payload is small if date of launch is not more than a few days out. Favorable conditions for lunar flight occur over a period of about a week during each month. In practice, duration of flight is most favorable when it is a multiple of half a day, 1½ days being the best choice. If the orbits of the planets round the Sun and all space-vehicle trajectories lie in one plane then for a space vehicle moving in the same direction as the Earth's orbit, the aphelion of the orbit will reach Mars if the initial velocity exceeds parabolic by 0.5 km/sec; Jupiter, by 3 km/sec; and Saturn, by 4 km/sec. If the vehicle is moving in the opposite direction to the Earth, it will reach Mercury if 2 km/sec above parabolic. Close approach to the Sun is more difficult than flying off to infinity. Optimum launch times to the planets occur periodically—every 2.14 years and 1.57 years for flights to Mars and Venus, respectively. Errors in initial conditions to miss the Moon's center by its radius are 10 m/sec in initial velocity and 0.4° in inclination of initial velocity when the initial velocity is 50 m/sec below parabolic. For hyperbolic orbits the errors are about 30 m/sec and 0.3° but only 15 m/sec and 0.2° when the hyperbolic orbit is in the plane of the Moon's orbit. An error of 10 sec in the instant of launch causes a 200-km displacement along the surface of the Moon. For flight to Mars, an error in initial velocity of 1 m/sec causes a lateral error of about 30,000 km when near Mars and motion of the vehicle needs to be corrected during flight. Author

**N63-14087** Cornell U. Center for Radiophysics and Space Research, Ithaca, N.Y.

**PHOTOMETRIC STUDIES OF COMPLEX SURFACES, WITH APPLICATIONS TO THE MOON**

Bruce Hapke and Hugh Van Horn Feb. 1963 55 p 24 refs Submitted for Publication

(NASA Grant NsG-119-61)

(CRSR 139) OTS: $5.60 ph, $1.85 mf

The reflection laws of a wide variety of surfaces have been measured. The factors which govern the optical scattering characteristics of complex surfaces are discussed, and the properties of surfaces which scatter light in the same manner as the moon are specified. Surfaces of solid rocks, volcanic slags, or coarsely-ground rock

powders do not possess the intricate structure necessary for backscattering light strongly. However, finely pulverized dielectric particles are able to build extremely complex surfaces which can reproduce the lunar scattering law. It is concluded that the surface of the moon is covered with a layer of fine rock dust composed of particles of the order of 10μ average diameter, and that 90% of the volume of the surface layer is voids. Author

**N63-14103** General Dynamics Corp. General Atomic Div., San Diego, Calif.

**ABUNDANCES OF THE FOURTEEN RARE-EARTH ELEMENTS PLUS YTTRIUM AND SCANDIUM IN METEORITES Quarterly Progress Report for the Period Ending February 15, 1963**

R. A. Schmitt, R. H. Smith, and D. A. Olehy Feb. 15, 1963 19 p 20 refs

(NASA Contract NASw-597)

(GA-3961) OTS: $1.60 ph, $0.80 mf

Absolute abundances of the 14 rare earth elements, and scandium and yttrium have been determined by neutron-activation analysis in four meteorites: a Type I carbonaceous meteorite, Orgueil; a eucritic, calcium-rich achondrite, Juvinas; a nakhlitic, calcium-rich achondrite, Lafayette; and a terrestrial Australian eclogitic specimen. In addition, abundances of the chalcophilic element, cadmium, were determined in the same meteorites and in seven iron meteorites. Results for the rare earth elements, and scandium and yttrium in meteorites are presented in tabular form; those for cadmium will be published later. A.R.B.

**N63-14203** Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena

**SOME MICROSTRUCTURES OF COMPLEX MORPHOLOGY OBSERVED IN PREPARATIONS OF CARBONACEOUS CHONDRITES MADE UNDER STERILE CONDITIONS**

Gregg Mamikunian and Michael H. Briggs [1962] 18 p 22 refs Submitted for Publication

OTS: $1.60 ph, $0.80 mf

A selection of photographs of some microstructures of complex morphology, observed in sterile preparations of various meteorites, is presented. Results of an examination of these microphotographs indicate that the preparations contained a variety of rare microstructures in circa 20μ size range. Although the structures are not readily identifiable, it is indicated that they are either unusual mineral grains or terrestrial materials which have contaminated the meteorite during museum storage. I.v.L.

## 30 SPACE VEHICLES

Includes: launch vehicle—spacecraft combinations; operating problems; and stability and control.

*For manned space capsules, satellites, and space probes see:* 32 Space Vehicles (Spacecraft).

*For boosters and rockets see:* 31 Space Vehicles (Launch Vehicles).

*For related information see:* 04 Aircraft; 08 Communication; and 22 Navigation and Guidance.

**N63-13826** Joint Publications Research Service, Washington, D.C.

**ROCKETS FLY ON COURSE**

Yu. Nikolayev Mar. 5, 1962 15 p Transl. from Ekon. Gaz. (Moscow), no. 10, Oct. 9, 1961 p 37

(JPRS-12784) Distributed by OTS

Methods of attaining precise rocket trajectories are discussed. In the active part of the trajectory, engines provide the required speed and place the rocket on course. Then the engines are cut off and the rocket passively responds to the laws of mechanics. The direction and orientation of rockets is controlled (1) by devices installed in the path of the exhaust gases in the rocket nozzle, (2) by heavy flywheel gyroscopes installed inside the rocket, and (3) by rocket engine tilting mechanisms. These types of equipment respond to commands from automatic control systems which may be located on the rocket (autopilot) or on the ground (telecontrol). The major components of autopilot systems are the gyroscope, the chronometer, and the accelerometer. Autopilot systems cannot respond to deviations from the assigned course; this defect is remedied in telecontrol systems which use coordinates received from tracking radar to compute the commands required to place the rocket on course. Special homing equipment is being developed which will guide future rockets along the shortest distance to their goal. M.P.G.

**N63-13857** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

**NOISE PROBLEMS ASSOCIATED WITH LAUNCHING LARGE SPACE VEHICLES**

Arthur A. Regier, William H. Mayes, and Philip M. Edgem, Jr. Repr. from Sound, v. 1, no. 6, Nov.–Dec. 1962 p 7-12 7 refs Previously issued as NASA publication; for abstract see N62-12883 08-30

**N63-13969** General Dynamics/Astronautics, Space Science Labs., San Diego, Calif.

**RADIATION OVERSHOOTS CAUSED BY TEMPERATURE DECREASES IN THE WAKE OF RE-ENTRY VEHICLES**

K. G. P. Sulzmann Sept. 1962 25 p 7 refs

(Contract DA-04-495-ORD-3383; ARPA Order 39-62; Proj. Defender) (AE62-0814)

The possibility of radiation overshoots which are induced by temperature decreases in the wake of hypersonic projectiles is discussed. An adiabatic expansion model and an equilibrium flow model are shown to cause such overshoots under certain conditions. These models, together with gun-range observations of hypersonic polyethylene projectiles, support the existence of a radiation overshoot in the wake of hydrocarbon-type ablators, which is caused by the formation of $CO_2$. Author

**N63-13986** National Advisory Committee for Aeronautics. Langley Aeronautical Lab., Langley Field, Va.

**FREE-FLIGHT INVESTIGATION AT TRANSONIC SPEEDS OF THE STABILITY CHARACTERISTICS OF A TAILLESS MISSILE CONFIGURATION HAVING A 45° SWEPTBACK WING OF ASPECT RATIO 4**

Richard G. Arbic Washington, NACA, Aug. 28, 1956 38 p 6 refs (NACA RM L56E11) OTS: $1.00 (Declassified)

A flight test of a long-range missile configuration having a 45° sweptback-wing of aspect ratio 4 was conducted between Mach numbers of 0.85 and 1.3 and a Reynolds number range of $3.6 \times 10^6$ to $7.4 \times 10^6$. Lateral pulse inputs resulted in combined longitudinal and lateral motions which were analyzed separately by a two-degree-of-freedom method for the longitudinal case and a three-degree-of-freedom vector method for the lateral case to obtain static and dynamic stability derivatives. The longitudinal flexible-wing results indicated a gradual transonic trim change and a lift-curve slope comparable with that for the same configuration with a wing of aspect ratio 5.5. Lateral derivatives were in reasonable agreement with referenced data for the higher Mach numbers but were thought to be slightly low for the lower Mach numbers. Author

**N63-14064** Northeastern U., Boston, Mass.

**EXPERIMENTAL INVESTIGATION FOR THE MEASUREMENT OF PARTICLE DAMAGE TO SURFACES OF SPACE VEHICLES Final Report**

Richard B. Oppenheim and Louis J. Nardone Dec. 31, 1962 27 p 10 refs
(Contract AF 19(604)-7311)
(AFCRL 63-206)

In support of the upper-air research program, activities conducted were primarily concerned with supplying support and engineering services to a program of experimental investigations on measurement of particle damage to surfaces of space vehicles. Weight loss and neutron activation methods are presented for determining surface-erosion effects. Description is given of an electrostatic charge detector which establishes whether a charge is actually carried by a micrometeorite, and the frequency of the occurrence of the charged particles as compared to the total micrometeorite flux. Included also are brief descriptions of membrane, grid and acoustic-type micrometeorite detectors. Support activities for the noctilucent cloud, micrometeorite collection, and artificial meteor programs are presented. Author

# 31 SPACE VEHICLES (LAUNCH VEHICLES)

Includes: boosters; clustered rockets; and multistage rockets.

*For propulsion engines see:* 27 Propulsion.

*For launch vehicle - spacecraft combinations see:* 30 Space Vehicles.

*For related information see:* 04 Aircraft; 08 Communications; and 22 Navigation and Guidance.

**N63-14025** National Aeronautics and Space Adminstration. Marshall Space Flight Center, Huntsville, Ala.

**LAUNCH DEFLECTOR DESIGN CRITERIA AND THEIR APPLICATION TO THE SATURN C-1 DEFLECTOR**

R. L. Evans and O. L. Sparks Washington, NASA, Mar. 1963 39 p 6 refs
(NASA TN D-1275) OTS: $1.00

Theoretical considerations pertinent to the successful design of dry-launch deflectors for super boosters are presented. Deflector configurations of many types, together with the particular configuration used in the launching of the C-1 Saturn booster, are described. It is concluded that the dry deflector can be successfully used to launch super boosters. In particular, it is predicted that the Saturn deflector may be used unlimitedly without the necessity of extensive overhaul and repairs. Author

# 32 SPACE VEHICLES (SPACECRAFT)

Includes: manned space capsules; satellites; and space probes.

*For boosters and rockets see:* 31 Space Vehicles (Launch Vehicles).

*For Launch vehicle—spacecraft combinations see:* 30 Space Vehicles.

*For related information see:* 04 Aircraft; 08 Communications; and 22 Navigation and Guidance.

**N63-13900** National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.

**INVESTIGATION OF THE LOW-SUBSONIC STABILITY AND CONTROL CHARACTERISTICS OF A ½-SCALE FREE-FLYING MODEL OF A LIFTING-BODY REENTRY CONFIGURATION**

James L. Hassell, Jr. Washington, NASA, July 1960 41 p 5 refs
(NASA TM X-297) OTS: $4.60 ph, $1.43 mf (Declassified)

An investigation of the low-subsonic stability and control characteristics of a ½-scale free-flying model of a rounded half-cone lifting-body reentry configuration has been made in the Langley full-scale tunnel. The static longitudinal and lateral stability characteristics were satisfactory, and the damping of the Dutch roll oscillation was good for all flight conditions tested. Although the lower pair of control surfaces employed as elevators provided a rather weak pitch control, this deficiency presented no particular problem in these tests since no abrupt changes occurred in trim or stability. The lateral control effectiveness decreased with increase in angle-of-attack and increased as the neutral setting of the upper pair of surfaces employed as ailerons was moved trailing-edge upward. Adequate lateral control could be obtained for angles-of-attack up to about 33° if the ailerons were initially trimmed about 40° trailing edge up. Author

**N63-13903** National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.

**SOME AERODYNAMIC AND CONTROL STUDIES OF LIFTING REENTRY CONFIGURATIONS AT ANGLES OF ATTACK UP TO 90° AT A MACH NUMBER OF 2.91**

Frank L. Clark and Joanna M. Evans Washington, NASA, Nov. 1960 49 p 2 refs
(NASA TM X-338) OTS: $4.60 ph, $1.67 mf (Declassified)

An investigation has been conducted in the Langley 9-inch supersonic tunnel at a Mach number of 2.91 to determine the stability and control characteristics of four triangular-wing lifting reentry configurations. The configurations were chosen as being typical of an airplane-like configuration which might reenter the earth's atmosphere at maximum lift or at an angle of attack of 90°. Longitudinal control for all models was provided by flaps which extended beyond the trailing edge of each wing. Rectangular holes were provided on each wing just ahead of the leading edge of the flaps in an effort to increase flap effectiveness. Directional stability was provided by 6.5° toed-in fins located at the tip of each wing. One model was tested over an angle-of-attack range from −4° to 90° for flap conditions ranging from the no-flap case to flap deflections of ±90°. This model was also tested over an angle-of-sideslip range of 4° to −15° at angles of attack up to 81°. Tests on the other three models were restricted to angles-of-attack below 36° and flap deflections of 0° and 5°. Results indicated that, for all flap deflections, maximum lift occurred at an angle-of-attack of 48°; however, the model could not be trimmed near this point. Values of maximum lift coefficient varied from about 0.73 to 0.80, depending on the flap deflection. Decreasing the flap deflection from 0° to −50° (rectangular holes opened) increased the trim angle-of-attack from 2° to about 12° and, for angles-of-attack greater than 15°, made the model neutrally stable over a large portion of the test angle-of-attack range. The presence of the rectangular holes had very little effect in increasing flap effectiveness. For flap deflections in the range from 50° to −50°, flap effectiveness increased as angle-of-attack was increased up to about 70°; further increase in angle-of-attack generally resulted in a reduction in flap effectiveness. The model was directionally stable at angles-of-attack of 0° and 30°. Author

**N63-13904** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**A WIND-TUNNEL INVESTIGATION AT SUBSONIC AND LOW SUPERSONIC SPEEDS OF A RE-ENTRY VEHICLE WITH RETRACTABLE WINGS**

Willard G. Smith Washington, NASA, Feb. 1961 21 p 4 refs
(NASA TM X-398) OTS: $2.60 ph, $0.83 mf (Declassified)

An experimental investigation was conducted to study the aerodynamic characteristics of a winged reentry vehicle, with emphasis on the lift capabilities and lift-drag ratios necessary for a glide landing. A blunted half-cone body was fitted with wings of triangular

planform which were shaped to match the body contours when retracted. Static longitudinal and lateral characteristics were measured at Mach numbers of 0.25, 0.90, and 2.20, and angles-of-attack of from -8° to 22° and sideslip angles of from -6° to 16°. Analysis indicated that the model with wings developed from the body had a sufficiently large lift-drag ratio to perform a safe glide landing. Author

**N63-13906** National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.

**STATIC LONGITUDINAL AERODYNAMIC CHARACTERISTICS AT TRANSONIC SPEEDS OF A LENTICULAR-SHAPED REENTRY VEHICLE**

John P. Mugler, Jr., and Walter B. Olstad Washington, NASA, Dec. 1960 30 p 5 refs
(NASA TM X-423) OTS: $2.60 ph, $1.10 mf (Declassified)

Tests have been made at transonic speeds on a lenticular-shaped reentry vehicle. The tests covered a Mach number range from 0.40 to 1.20 at angles-of-attack from approximately -3° to 102°. Tests were made on body-alone and body-fin configurations. The Reynolds number based on body length varied during the tests from about $1.2 \times 10^6$ to $4.4 \times 10^6$. The results indicate that the body-alone configuration was statically unstable at angles-of-attack near 0° and stable at angles-of-attack near 90°. Addition of horizontal fins with no deflection resulted in a neutrally stable configuration near 0° at most Mach numbers and slightly increased the stability at angles-of-attack near 90°. At transonic speeds and moderate angles-of-attack, separated flow was prominent on the body upper surface and caused horizontal-fin ineffectiveness at these test conditions. Deflecting the fins -20° caused the configuration to trim at a higher angle-of-attack at all Mach numbers. Maximum lift-drag ratios of about 5.5 were obtained on both the body-alone and body-fin configurations at $M = 0.4$, and this value diminished to about 1.0 at low-supersonic speeds. Author

**N63-13907** National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.

**FREE-FLIGHT INVESTIGATION AT SUPERSONIC SPEEDS OF THE STABILITY AND DRAG OF A 79° CLIPPED DELTA BOOST-GLIDE CONFIGURATION INCLUDING AN ANALOG STUDY OF COUPLED MOTIONS DURING THE FLIGHT**

Sherwood Hoffman and Willard S. Blanchard, Jr. Washington, NASA, Jan. 1961 61 p 19 refs
(NASA TM X-425) OTS: $6.60 ph, $2.03 mf (Declassified)

A free-flight investigation was conducted at Mach numbers between 1.2 and 3.4 to determine the aerodynamic characteristics and motions of a rocket-boosted model of a simplified boost-glide hypersonic configuration. The model had a 79° clipped-delta planform, sharp leading edges, a blunt base, and symmetry in two planes. The mass moment of inertia in roll was about 4 percent of the value in pitch or yaw. The model was both statically and dynamically stable near Mach number 3 at small angles-of-attack and slideslip. A disturbance in pitch to an angle-of-attack of about 12° resulted in roll oscillations and reversals, and coupling of the longitudinal and lateral forces. An analog study, in which the equations-of-motion for five degrees of freedom were used, generally simulated the magnitudes and frequencies of the angular motions, and showed that the rate of change of effective dihedral derivative with angle-of-attack was a necessary derivative for simulating the coupled motions at the altitude and velocity of the test. Linearized theory gave reasonable predictions of the pressure drag and of the static and dynamic stability derivatives for oscillations of small amplitude. Author

**N63-13908** National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.

**STATIC STABILITY AND CONTROL CHARACTERISTICS AT LOW-SUBSONIC SPEEDS OF A LENTICULAR REENTRY CONFIGURATION**

George M. Ware Washington, NASA, Dec. 1960 18 p 3 refs
(NASA TM X-431) OTS: $1.60 ph, $0.80 mf (Declassified)

An investigation of the static stability and longitudinal control characteristics at low-subsonic speeds of a manned reentry configuration capable of high-drag reentry and glide landing has been made in the Langley free-flight tunnel. The model was lenticular in shape (double convex in cross section and circular in planform) and had several canopy designs and two horizontal-fin and end-plate combinations. The fin unit was designed to fold up during the high-drag reentry phase and to extend horizontally for the glide landing. The body alone was longitudinally unstable about the 40-percent body-length point from an angle-of-attack of 0° to about 25° and stable from 25° to 90°. The addition of horizontal fins provided positive longitudinal stability throughout the angle-of-attack range but slightly reduced the untrimmed lift-drag ratio of the body. The addition of canopies to the upper surface of the body resulted in reductions in the lift-drag ratio. Deflecting the fin units was an effective means of obtaining pitch control. The investigation indicated that the model with three small bubble canopies and modified horizontal-fin and end-plate combination had satisfactory static lateral stability characteristics up to the stall. Author

**N63-13909** National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.

**AN INVESTIGATION AT SUBSONIC SPEEDS OF THE LONGITUDINAL AERODYNAMIC CHARACTERISTICS AT ANGLES OF ATTACK FROM -4° TO 100° OF DELTA-WING REENTRY CONFIGURATIONS HAVING VERTICALLY DISPLACED AND CAMBERED WING-TIP PANELS**

Bernard Spencer, Jr. Washington, NASA, Feb. 1961 34 p 10 refs
(NASA TM X-440) OTS: $3.60 ph, $1.22 mf (Declassified)

An investigation was made in the Langley high-speed 7- by 10-foot tunnel at Mach numbers from 0.40 to 0.80 to determine the longitudinal stability and control characteristics associated with a 73° delta-wing configuration having cambered and vertically displaced wing-tip panels. The use of trailing-edge flaps on the wing-tip panels as a method of providing longitudinal control in a normal range of angles-of-attack (-2° to 50°), and the use of fuselage nose tabs as a means of providing trim or control at high angles-of-attack (100° to 60°) were studied. A cranked-delta-wing configuration was also tested. Unfolding fuselage nose tabs on the 73° delta-wing configuration indicated feasible trim control for maintaining the configuration at an angle-of-attack near 90°. The use of a cranked-leading-edge wing having the basic vertically displaced and cambered wing-tip panels indicated a fairly linear variation of pitching moment with angle-of-attack, and reduced the degree of pitch-up noted for the basic 73° delta wing having the same wing-tip panels. Author

**N63-13910** National Aeronautics and Space Administration. Langley Research Center, Langley Field, Va.

**EFFECT OF LONGITUDINAL AND LATERAL CONTROLS ON AERODYNAMIC CHARACTERISTICS OF A WINGED REENTRY CONFIGURATION AT A MACH NUMBER OF 1.97 AND ANGLES OF ATTACK UP TO APPROXIMATELY 90°**

Gerald V. Foster Washington, NASA, Feb. 1961 13 p 3 refs
(NASA TM X-449) OTS: $1.60 ph, $0.80 mf (Declassified)

An investigation has been conducted in the Langley 4- by 4-foot supersonic pressure tunnel to determine the effects of longitudinal and lateral controls on the aerodynamic characteristics of a high-drag reentry configuration at a Mach number of 1.97. The configuration utilized a 73°-sweptback clipped delta wing. The results obtained with leading-edge pitch controls of various sizes indicated a progressive increase in pitch effectiveness as the control size was increased. The use of differentially deflected wing-tip lateral controls indicated that substantial roll effectiveness was available with relatively small changes in pitching moment. Author

**N63-13913** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**SUBSONIC AERODYNAMIC CHARACTERISTICS OF DISK RE-ENTRY CONFIGURATIONS WITH ELLIPTIC CROSS SECTIONS AND THICKNESS-DIAMETER RATIOS OF 0.225 AND 0.325**

Fred A. Demele and Jack J. Brownson Washington, NASA, May 1961 46 p 9 refs

(NASA TM X-566) OTS: $4.60 ph, $1.58 mf (Declassified)

An investigation has been made to determine the longitudinal and lateral-directional aerodynamic characteristics of two disk-shaped reentry configurations employing trailing-edge control surfaces, vertical stabilizing surfaces, and canopies. The models had elliptic profiles with maximum thickness-diameter ratios of 0.225 and 0.325. The tests were conducted to maximum angles-of-attack of 28° and angles of sideslip of 19° over a range of Mach numbers from 0.25 to 0.90 at a Reynolds number of $3.3 \times 10^6$ and at Reynolds numbers to $16 \times 10^6$ at a Mach number of 0.25. It was found that with the moment center located at 40 percent of the diameter, both model configurations were longitudinally stable at low speeds. At Mach numbers from 0.80 to 0.90, the models exhibited varying degrees of instability up to the region near maximum lift, wherein a stable trend in the pitching moments normally occurred. Deflection of the trailing-edge flaps resulted in practically no adverse effects on the lift-drag ratios at low speeds and was an effective means for trim change. At low speeds and for a lift coefficient of about 0.4, the trim lift-drag ratio for the model having a thickness-diameter ratio of 0.225 was 6, and that for the thicker model was almost 5. Both models were directionally stable and exhibited positive effective dihedral throughout the Mach number range. Author

**N63-13914** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**THE SUBSONIC AERODYNAMIC CHARACTERISTICS OF SOME BLUNT DELTA CONFIGURATIONS WITH 75° SWEEPBACK**

George G. Edwards and Howard F. Savage Washington, NASA, Oct. 1961 65 p 3 refs

(NASA TM X-581) OTS: $6.60 ph, $2.15 mf (Declassified)

A wind-tunnel investigation has been conducted at subsonic speeds to study the effects on performance and stability of modifications to a delta planform wing with 75°-sweepback. Six-component force and moment data, together with base pressure, are presented for a number of delta wings all having the same planform but with a variety of thickness distributions, leading-edge shapes, and base areas. Also investigated were the effects of a small and a large fuselage, fuselage boattailing, tip-mounted vertical surfaces, and elevon controls. The effects of variation of Reynolds numbers from 2.2 million to 22 million at a constant Mach number of 0.25 and the effects of variation of Mach number from 0.25 to 0.90 at a constant Reynolds number of 2.2 million are included for selected configurations. Author

**N63-14101** National Aeronautics and Space Administration, Washington, D. C.

**NASA TO LAUNCH ATMOSPHERIC STRUCTURE SATELLITE News Release No. 63-59**

Mar. 26, 1963 15 p

Available from NASA. Office of Scientific and Technical Information, Wash., D. C.

The Atmospheric Structure Satellite (S-6), to be launched by a Delta vehicle in the near future, will carry experiments to measure the density, composition, pressure and temperature of the atmosphere at altitudes between 155 and 580 miles. The satellite will carry two neutral mass spectrometers to directly measure electrically neutral particles in space. The satellite is designed to be nearly leakproof, since gas escaping from the craft would interfere with accurate measurement of the space environment. Electrical power to the satellite will be supplied by silver-zinc chemical batteries with an expected useful lifetime of two to three months. S-6 is the first scientific earth satellite containing a new pulse code modulation telemetry system which is capable of supplying 40 separate channels of information in digital form. Two separate command receivers will permit experiment selection while the satellite is in orbit. M.P.G.

**N63-14121** National Aeronautics and Space Administration, Washington, D.C.

**RELAY I FULFILLS MISSION OBJECTIVES News Release No. 63-57**

Mar. 22, 1963 7 p

Available from NASA. Office of Scientific and Technical Information, Wash., D.C.

The Relay I satellite has successfully performed all of its experiments and missions including testing intercontinental microwave communication, measuring energy levels of space radiation in orbit, and determining radiation damage to solar cells and electronic components. In view of the success of Relay I, very few changes will be made in the design of the second Relay satellite which is scheduled for launch by NASA in the third quarter of 1963. R.C.M.

## 33 STRESSES AND LOADS

Includes: fatigue; vibration; flutter; and structural tests.

*For related information see:* 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings and Control Surfaces; and 34 Structural Design.

**N63-13789** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

**STRENGTH OF FILAMENTARY SHEETS WITH ONE OR MORE FIBERS BROKEN**

George W. Zender and Jerry W. Deaton Washington, NASA, Mar. 1963 9 p 2 refs

(NASA TN D-1609) OTS: $0.50

Experimental static-stress-concentration factors at failure for a filamentary material containing unidirectional dacron fibers and subjected to tensile loads are presented and compared with previously published theoretical results. The favorable agreement of the theoretical and experimental results indicates the theory is valid for the static-load case. Author

**N63-13829** Douglas Aircraft Co., Inc., Aircraft Div., Long Beach, Calif.

**CRACK PROPAGATION PREDICTION AND CRACK STOPPER TECHNIQUES FOR STIFFENED CYLINDERS IN A SUPERSONIC TRANSPORT ENVIRONMENT First Quarterly Literature Summary [Apr. 1–June 30, 1962]**

J. G. Elliott Wright-Patterson AFB, Ohio, Aeronautical Systems Div., July 1, 1962 9 p 12 refs

(Contract AF 33(657)-8546)

(DAC-30932)

A summary of current technical publications on crack propagation prediction and crack stopper techniques for stiffened cylinders in a supersonic transport environment is presented. The literature has been abstracted, indexed, bibliographically listed and collated into topical summaries. The project is divided into three phases: Phase I, Basic Crack Propagation Study; Phase II, Development of Crack Arresting Configurations; and Phase III, Structural Cylinder Investigation. Author

**N63-13841** New York U., N.Y.

**CORRELATION OF PLATE CREEP BUCKLING THEORY WITH EXPERIMENTS ON LONG PLATES OF ALUMINUM ALLOY 2024-0 AT 500° F Technical Documentary Report [February 1962 to August 1962]**

Ralph Papirno and George Gerard Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, Sept. 1962 39 p 7 refs
(Contract AF 33(657)-8233)
(ASD-TDR-62-865)

The results of creep buckling experiments on long, simply supported plates of aluminum alloy 2024-0 at 500° F under axial compression were correlated with a previously developed theory for perfect plates. Compressive creep properties of the test material were obtained to develop the theoretical results. The plate experiments were performed using a square-tube configuration as an evaluation program indicated that the conventional vee-groove—knife-edge arrangement for simulating simple support was unsatisfactory for use at elevated temperatures. The theory was found to have predicted value for plate creep buckling when used in normalized form. A simplified approach for predicting creep crippling was also correlated with the test data. Author

**N63-13882** National Advisory Committee for Aeronautics. Langley Aeronautical Lab., Langley Field, Va.

**EFFECT OF CONTROL TRAILING-EDGE THICKNESS OR ASPECT RATIO ON THE OSCILLATING HINGE-MOMENT AND FLUTTER CHARACTERISTICS OF A FLAP-TYPE CONTROL AT TRANSONIC SPEEDS**

William C. Moseley, Jr., and Robert F. Thompson Washington, NACA, Apr. 23, 1958 44 p 9 refs
(NACA RM L58B25) OTS: $4.60 ph, $1.52 mf (Declassified)

Free-oscillation tests were made in the Langley high-speed 7- by 10-foot tunnel to determine the effect of control trailing-edge thickness and control aspect ratio on the dynamic hinge-moment characteristics of a trailing-edge, flap-type control. The semispan-wing-control model had an aspect ratio of 1.80, a taper ratio of 0.74, 0° sweep of the 0.40-chord line, and a modified NACA 64A004 airfoil section. The total control chord was 30 percent of the wing chord, and the controls were hinged at the 0.778 wing-chord line. Tests at Mach numbers from 0.60 to 1.01 were made for a range of oscillation reduced frequency at an angle-of-attack of 0°. Aerodynamic damping in the control rotational mode was unstable for the original or basic control configuration previously investigated. Results of the present investigation indicate that either increases in control trailing-edge thickness or decreases in control aspect ratio had a beneficial or stabilizing effect on the control aerodynamic damping. The variation of the aerodynamic damping derivative with oscillation amplitude was generally nonlinear and the amplitude over which the damping was stable increased with increasing trailing-edge thickness or decreasing aspect ratio. The one-degree-of-freedom control-surface flutter of the model could be eliminated for all test conditions by proper choice of control trailing-edge thickness or control aspect ratio. Oscillating the control had only small effects on the aerodynamic in-phase or spring-moment derivatives for the test range of control parameters. The magnitude of the variation in spring-moment derivative with Mach number at transonic speeds was decreased by increasing the control trailing-edge thickness or decreasing the control aspect ratio. The effect of control aspect ratio on the dynamic hinge-moment derivatives is in qualitative agreement with existing unsteady flow theory. Author

**N63-13924** Douglas Aircraft Co., Inc. Aircraft Div., Long Beach, Calif.

**CRACK PROPAGATION PREDICTION AND CRACK STOPPER TECHNIQUES FOR STIFFENED CYLINDERS IN A SUPERSONIC TRANSPORT ENVIRONMENT Third Quarter Literature Summary, 1 April 1962 to 31 December 1962**

R. T. Hunt, G. R. Eide, and F. J. Hotze (McDonnell Aircraft Corp.) Jan. 1, 1963 11 p 16 refs
(Contract AF 33(657)-8546)
(DAC-31150)

This quarterly report presents a summary of pertinent current technical publications that were reviewed during the period 1 April 1962 through 31 Dec. 1962. Author

**N63-13936** Midwest Research Corp., Kansas City, Mo.

**STUDY OF ULTRASONIC METHODS FOR NONDESTRUCTIVE MEASUREMENT OF RESIDUAL STRESS [Final] Technical Documentary Report, Part II, [1 February 1961 to 31 January 1962]**

Fred R. Rollins, Jr., Donald R. Kobett, and Jerry Lee Jones Wright-Patterson AFB, Ohio, Directorate of Materials and Processes, Jan. 1963 36 p 11 refs
(Contract AF 33(616)-7058)
(WADD-TR-61-42, Pt. 2)

The study of stress-induced birefringence has been continued in both polycrystalline and single crystal experiments. The effect is explained on the basis of nonlinear elasticity theory. Experiments indicate that dislocation activity does not strongly affect results in polycrystalline specimens; however, a pronounced influence may be observed in single crystals. Nonlinear elasticity theory has been used to investigate the interaction of two intersecting, plane, elastic waves in a homogeneous, isotropic medium. A criterion for the occurrence of a strong scattered wave has been derived. The criterion is formulated as a relationship between the second order elastic constants of the material, the angle between the intersecting wave vectors, and the ratio of primary wave frequencies. The amplitude of the scattered wave is found to be proportional to the volume of interaction and dependent on the third order elastic constants of the material. Preliminary efforts to experimentally verify the theoretical predictions are described. Author

**N63-13966** Douglas Aircraft Co., Inc., Aircraft Div., Long Beach, Calif.

**CRACK PROPAGATION PREDICTION AND CRACK STOPPER TECHNIQUES FOR STIFFENED CYLINDERS IN A SUPERSONIC TRANSPORT ENVIRONMENT Semi-Annual Technical Progress Report [April 1-Sept. 30, 1962]**

R. T. Hunt Oct. 1, 1962 89 p 20 refs
(Contract AF 33(657)-8546)
(DAC-31044)

This interim report describes the work accomplished on the subject contract during the first six-month period. Emphasis has been placed on the analytical and digital tools required for optimization of crack-stopper configurations, development of testing techniques for the Phase I cylindrical specimens, and evaluation of alternate flat sheet specimens for the Phase I test program. Author

**N63-13967** Aeronautical Research Council (Gt. Brit.)

**THE BUCKLING OF PLATES TAPERED IN THICKNESS**

G. G. Poper London, HMSO, 1963 18 p 3 refs
(ARC-R&M-3309; previously issued as RAE-R-STRUCT-272, ARC-23517) Available from HMSO:7s.

An analysis is given of the buckling of rectangular plates tapered in thickness under uniform end-load in the direction of taper, with opposite pairs of edges either clamped or simply-supported. Author

**N63-13974** Oak Ridge National Lab., Tenn.

**THE EFFECT OF STRESS STATE ON HIGH-TEMPERATURE LOW-CYCLE FATIGUE**

C. R. Kennedy Mar. 21, 1963 27 p 11 refs
(Contract W-7405-eng-26)
(ORNL-3398)

A study of the behavior of Inconel at 1500° F under realistic dynamic-stress states has been accomplished. The purpose of this work was to critically evaluate present criteria used to solve low-cycle fatigue problems and to demonstrate their applicability for the more complex situations. The relative agreement between the static complex stress-creep-rupture results and the low-cycle fatigue data is demonstrated. From the relationships developed for static complex stress-creep-rupture data, it is demonstrated that the magnitudes of the effects of stress state and frequency on low-cycle fatigue can be determined. Author

**N63-14006** California Inst. of Tech. Graduate Aeronautical Labs., Pasadena

**AMES TESTS ON THE FLUTTER OF CYLINDRICAL SHELLS**

R. O. Stearman, M. H. Lock and Y. C. Fung Dec. 1962 64 p 21 refs

(Supported by AFOSR)

(SM-62-37)

Two series of experiments on the flutter of thin-walled circular cylinders were performed at the Ames Unitary Plan Wind Tunnel. In the first series (June 1961), although the model had a radius-to-thickness ratio of 1333 and was designed to flutter according to all published theories based on potential flow, no flutter occurred except in the vicinity of buckling conditions. In the second series (May 1962), models having radius-to-thickness ratios 1951 and 2500 were tested, and flutter was observed. This paper describes the experimental results and their interpretations. Author

**N63-14023** General Dynamics/Convair, San Diego, Calif.

**INFLUENCE OF RESIDUAL STRESSES AND STIFFNESS FACTORS ON FATIGUE STRENGTH OF METALS AND STRUCTURES**

Clarence R. Smith Mar. 1962 43 p 11 refs

(Contract AF 33(616)-8228)

(GDC-62-55A; ERR-SD-170)

The influence of residual stresses and stiffness factors on fatigue strength of metals and structures is considered. The fatigue of metals and structures is presented as a series of small problems rather than as one large problem. An effort is made to visualize fatigue as taking place in highly-localized areas wherein stresses can be made to behave as though they were acting either at different amplitudes, or at different maximum values, than a direct proportion of their loading would indicate. A method is presented for ascertaining local stresses by fatigue testing a part to failure at such load that localized yielding is assured. A method is also given for estimating fatigue life. This is the method designated by the United States Air Force as The Smith Method for Estimating Fatigue Life. Recommendations are made for specific ways to improve the fatigue life of metals and structures through the use of specially-designed high-interference-fit bushings, tapered bolts, thin-auxiliary doublers, tightly driven rivets, and edge-driven rivets. Author

**N63-14051** Hanford Atomic Products Operation, Richland, Wash.

**PROTOTYPE BURST TEST UNIT FOR IRRADIATED PRESSURE TUBES**

(Contract AT(45-1)-1350)

(HW-76158) OTS: $0.50

To perform elevated-temperature burst tests on irradiated pressure tubes, a bell jar-type pressure containment vessel was designed to enclose the specimen, blast shield, and furnace. This vessel excludes water from the hot specimen and furnace during testing and contains the pressure surge that occurs when the hot pressurized water in the specimen flashes to steam upon failure of the test specimen. Following cold testing, the prototype apparatus was installed. To date, eleven sections of irradiated pressure tubes have been tested at a temperature of 280° C. It is now possible to maintain temperatures on a 20-inch specimen to within 5° C of an average temperature of 280° C. Special tools and jigs were developed to simplify the complex tasks of underwater assembly and disassembly of the test piece and installation of the test piece in the containment vessel. Several design modifications were developed as a result of the operation of the prototype unit. Author

**N63-14058** Directorate of Materials and Processes, Aeronautical Systems Div., Wright-Patterson AFB, Ohio

**AGING STUDY OF 2024 ALUMINUM BY DYNAMIC MODULUS TECHNIQUES [Final] Technical Documentary Report [April 1961 - June 1962]**

G. W. King Nov. 1962 20 p 14 refs

(ASD-TDR-62-829)

Dynamic modulus measurements are used to study precipitation rates in 2024 aluminum alloy. The results are discussed in terms of the effect of structural changes on the elastic modulus as well as the kinetics of precipitation at various stages of the age-hardening process. Activation energies were determined for aging in the temperature ranges from room (77° F) to 130° F, and 375° F to 425° F. A value of 20.7 kcal/gm mole was obtained for the lower temperature range, and 23 kcal/gm mole for the higher temperatures. The data indicate that modulus changes are primarily influenced by the structure of the second phase; however, some evidence of strain energy effects are indicated. Author

**N63-14067** Stanford U., Calif.

**STRESSES IN AND DEFORMATION OF A PRESTRESSED, VERY THIN SHELL SUBJECT TO ADDITIONAL LOAD Final Report**

W. Flügge Feb. 1, 1963 6 p

(Contract DA-ARO(D)-31-124-G61)

(AROD-3065-1)

Problems relating to additional loading of prestressed very thin shells were studied as follows: (1) the shape which a very thin shell of revolution will assume when it is inflated was calculated for the case of the toroid shell and for the case in which an arbitrarily low inflation pressure is chosen; (2) the initial shape was calculated which a toroid shell must have if, after being inflated, it is to deflate to a prescribed shape; (3) the stresses and deformations of an inflated very thin shell, which are produced by small additional loads, were calculated; and (4) the influence of the flexural rigidity, however small, of an inflated very thin shell on its response to small additional loads was investigated. M.P.G.

**N63-14093** College of Aeronautics, Cranfield (Gt. Brit.)

**STRESS DISTRIBUTION IN A PRESSURISED THICK WALLED TOROIDAL SHELL**

A. Kornecki (Technion Res. and Dev. Foundation) Jan. 1963 18 p 5 refs

(CoA Note 137)

An investigation is made of the state of stress in a closed toroidal shell of uniform thick-walled circular cross section when the shell is loaded by uniform internal and external pressures. The general equations of the classical theory of elasticity, expressed in terms of stress components, are solved approximately by expanding the solutions in power series in a small parameter (a/R) (a is the external radius of the cross section and R the radius of the axis). The first approximation yields the known solution of the problem of Lame for a thick-walled cylinder. The equations for the higher approximations reduce to the problem of plane strain in a circular ring. Only the first three terms of the power series are calculated in this report. Author

**N63-14097** Illinois U., Urbana

**RELATIVELY UNEXPLORED ASPECTS OF FRACTURE MECHANICS**

George R. Irwin (Naval Res. Lab.) Feb. 1963 52 p 31 refs

A Summary of the third of three Series of lectures delivered Oct. 1961 For abstract of second group of lectures see N63-10721 02-33

(Supported by Ford Foundation Fund)

(T&AM-240)

The lectures summarized here were devoted to certain fields of fracture mechanics. The relatively new fields discussed are: (1) cracking due to stress, plus chemical environment and/or fatigue; (2) cracking of composites such as concrete, rocks, and soils; (3) separation of adhesive joints. Discussions of three additional topics, not new, were added because additional progress in these fields is essential to advancement of fracture research. These are: (1) effects of strain rate and temperature; (2) influence of flaws upon fracture strength when represented statistically; (3) a possible rate-theory basis for fracturing. Author

**N63-14114** Glasgow U. (Gt. Brit.)
**INTRODUCTORY SURVEY**
W. J. Duncan *In* Advisory Group for Aeronautical Research and Development, Paris (France) Manual on Aeroelasticity. Part V. Factual Information on Flutter Characteristics [1961] 53 p 42 refs (See N63-14113 09-01)

An introductory survey of aeroelasticity includes: (1) selection of the appropriate variables and their use in formulating equations of motion; (2) use of arbitrary displacement modes and resonance modes as displacement functions for the semirigid representation of structure; (3) determination of the increments or deviations in the aerodynamic forces associated with small changes in the general attitude and speed of the aircraft and with small distortional displacements and control-surface movements; (4) methods for solving the dynamic equations associated with the theory of aeroelasticity; (5) stability and stability criteria of a system wherein the equations of motion are linear with constant coefficients; (6) oscillatory and nonoscillatory aeroelastic phenomena; (7) effect of increased elastic stiffness on critical divergence speeds; (8) reversal of aileron control; (9) types and causes of flutter; (10) theoretical prediction of critical flutter speeds; (11) choice of the degrees of freedom to be employed in theoretical calculation of flutter or in simulator tests; (12) influence of aeroelasticity on general stability, control, and response characteristics of an aircraft; (13) model and full-scale flutter tests; (14) prevention of flutter; (15) impulse loading due to landing, gusty conditions, blast from explosions, and sudden applications of controls; (16) buffeting and noise; (17) kinetic heating of an airfoil or other body moving through a gas; and (18) practical aspects of aeroelasticity as applied to mechanical systems containing backlash, systems subject to solid friction, and problems of power-operated controls. I.v.L.

**N63-14116** Royal Aircraft Establishment, Farnborough (Gt. Brit.)
**WING FLUTTER**
D. R. Gaukroger *In* Advisory Group for Aeronautical Research and Development, Paris (France) Manual on Aeroelasticity. Part V. Factual Information on Flutter Characteristics [1961] 48 p 29 refs (See N63-14113 09-01)

This investigation includes the general properties of wing flutter, and wing flutter as affected by: sweepback; aspect ratio; taper ratio; cordwise section; incidence; torsional and flexural stiffness; flexural axis position; changes in stiffness distribution; structural damping; mass distribution; wing density and height; addition of localized or concentrated masses; and symmetric and antisymmetric root freedoms. I.v.L.

**N63-14117** National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
**FLUTTER OF CONTROL SURFACES AND TABS**
Arthur A. Regier *In* Advisory Group for Aeronautical Research and Development, Paris (France) Manual on Aeroelasticity. Part V. Factual Information on Flutter Characteristics [1961] 40 p 44 refs (See N63-14113 09-01)

This review includes: flutter prevention of flap-type controls at subsonic speeds by means of mass balancing; the effect of different speed ranges on the problem of flutter prevention; and single-degree-of-freedom flutter due to all-movable controls. I.v.L.

**N63-14118** Royal Aircraft Establishment, Farnborough (Gt. Brit.)
**FLUTTER OF POWERED CONTROLS AND OF ALL-MOVING TAIL-PLANES**
A. D. N. Smith *In* Advisory Group for Aeronautical Research and Development, Paris (France) Manual on Aeroelasticity. Part V. Factual Information on Flutter Characteristics [1961] 23 p 4 refs (See N63-14113 09-01)

Interplay of mass balance, circuit stiffness, and damping on control surface flutter, and flutter characteristics of all-moving tail-planes are investigated. I.v.L.

**N63-14119** National Physical Lab., Teddington (Gt. Brit.)
**FLUTTER IN ONE DEGREE OF FREEDOM**
N. C. Lambourne *In* Advisory Group for Aeronautical Research and Development, Paris (France) Manual on Aeroelasticity. Part V. Factual Information on Flutter Characteristics [1961] 44 p 63 refs (See N63-14113 09-01)

This review includes: modes of motion which exhibit oscillatory instability; the conditions under which this type of instability can occur; the various mechanisms by which the oscillations are initiated; and, where possible, the means whereby an instability can be avoided. The information presented in this review is mostly either from theoretical calculations for two-dimensional flow or from experiments with models in wind tunnels. I.v.L.

**N63-14176** Naval Ordnance Lab., White Oak, Md.
**ON THE USE OF A SPRING-MASS TO APPROXIMATE A BAR-MASS SYSTEM SUBJECTED TO A RECTANGULAR-FORCE PULSE**
Arnold E. Seigel and Robert H. Waser (M. S. Thesis - Maryland U., 1962) and Robert H. Waser
(Ballistics Res. Rept. 76; NOLTR 62-148)

The purpose of this study is to examine the validity of approximating a bar-mass system by a spring-mass system. The bar of mass m is built in at one end and has a rigid mass of mass M connected to the other end. A rectangular-step-force pulse of magnitude such that the bar is elastically deformed is considered to be applied to the rigid mass. The resulting behavior of the bar-mass system is calculated by the method of characteristics, with the assumption that the stresses in the bar are one-dimensional. The calculations yield the fact, not heretofore realized, that large errors may result from the use of the spring-mass approximation. Thus, it is unexpectedly found that, for long-duration pulses, the ratio of the maximum force, $F_{max}$, experienced by the bar to the applied force, $F_o$, is greater than 2 (reaching 2.43 at the larger m/M ratios), whereas the ratio is exactly 2 for the spring-mass approximation. For short duration pulses, it is found that the error in $F_{max}/F_o$, resulting from the use of the spring-mass approximation, is even larger than for the long-duration cases. To confirm the calculations, an experimental check of one of the calculated cases was performed. Author

**N63-14213** Stanford U. Div. of Engineering Mechanics, Calif.
**THE LINEAR THERMOELASTIC PROBLEM OF UNIFORM HEAT FLOW DISTURBED BY A PENNY-SHAPED INSULATED CRACK**
A. L. Florence and J. N. Goodier Feb. 1963 21 p 6 refs
(Contract Nonr-225(29))
(Tech. Rept. 137)

A solution for the infinite solid is obtained by the method of dual integral equations. Results are expressed mainly in closed forms, singular round the edge of the crack. The stress components in the plane of the crack are shown in curves. Author

**N63-14227** Naval Ordnance Test Station, China Lake, Calif.
**COUPLING PERTAINING TO A STEEL SPHERE IMPACTING THE ENDS OF RODS OF VARIOUS MATERIALS**
John S. Rinehart (Colorado School of Mines) Nov. 1962 17 p
(N123-(60530)23585A)
(NOTS-TP-3069; NAVWEPS-8064)

A method of measuring coupling between an energy source and a material has been developed, and some preliminary tests have been performed. Elastic waves were introduced into metal and Plexiglas rods by impacting one end of each kind of rod with a steel sphere. The strain pulses produced in the rods were sensed by resistance strain gages cemented to the sides of the rods and recorded on an oscilloscope. The respective peak strains, pulse durations, peak stresses, momenta, and energies of the strain pulses were then related to the respective mass densities, specific acoustic resistances, and Young's modulii in order to gain some familiarity with the parameters that control coupling. Excellent correlation was found between the momentum in the pulse and the Young's modulus of the material. Reasonably good correlation was found with several of the other parameters. However, the results of the tests indicate that the technique, while having some merit for the study of coupling between impacting spheres and long rods, does not appear particularly useful for the study of coupling between explosives and rocks. Author

## 34 STRUCTURAL DESIGN

Includes: structural elements; and weight analysis.

*For related information see:* 02 Aerodynamics of Bodies, Combinations, and Internal Flow; 03 Aerodynamics of Wings and Control Surfaces; and 33 Stresses and Loads.

**N63-13799** Hayes International Corp., Birmingham, Ala.
**FEASIBILITY OF REINFORCED PLASTICS FOR PRIMARY STRUCTURE OF ARMY AIRCRAFT**
L. R. Anderson et al Fort Eustis, Va., Army Transportation Research Command, Mar. 1963 262 p 76 refs
(Contract DA-44-177-TC-756)
(Rept. 743; TRECOM-TR-63-15)

Recent advances in the technology of reinforced plastics have produced composite materials which have strength properties equal to those of heat-treated steel with weights approximately the same as magnesium. These materials have been used quite extensively in nonstructural parts for aircraft. Recently their use in secondary structural applications and some primary structure has steadily increased. The objective of this program was to determine the feasibility of using reinforced plastics in highly stressed Army aircraft structures and components by design studies and the fabrication and testing of reinforced plastic specimens. This document is the final report of the investigation. It contains the results of the design studies, the results of all tests, conclusions, and recommendations. Author

**N63-14024** Grumman Aircraft Engineering Corp., Bethpage, N.Y.
**FAVORABLE WING-BODY INTERFERENCE FOR AIRCRAFT AT SUPERSONIC SPEED: AN ANALYTIC STUDY OF DESIGN PARAMETERS [Final Report]**
R. C. Meyer Aug. 9, 1962 147 p 8 refs
(Contract NOas-60-6125-c)

The level and trend of wave drag decrements due to favorable wing-body interference are examined using linear theory. Upper limits of zero-lift drag reduction corresponding to optimal fuselage indentation are presented. A brief check on the adverse effect of limited afterbody length is also included. The foremost factors determining the theoretically attainable zero-lift drag reduction are seen to be: wing reduced aspect ratio, fuselage width, afterbody length, and shape of the basic fuselage cross section. Author

**N63-14222** Aeronautical Systems Div., Flight Accessories Lab., Wright-Patterson AFB, Ohio
**EXPANDABLE STRUCTURES FOR AEROSPACE APPLICATIONS**
F. W. Forbes [1962] 137 p 34 refs Presented to the British Interplanetary Soc., 1 May 1962

This paper discusses the history and the future of expandable structures in space applications. This discussion covers the areas of inflatable balloons, rigidized balloons, Goodyear airmat, foamed-in-place, expandable honeycomb, and unfurlable structures in the areas of concept description, actual applications, materials, generalized design procedures, future applications, advantages, and the disadvantages of each system. It is pointed out that there is no one universal expandable structure system that will meet the requirements of all applications. However, recommendations are made concerning specific applications for each of the above-mentioned six concepts. It is concluded that expandable structures definitely do have a role in future space applications. Author

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